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Chemical Contaminants in Edible, Non-Salmonid Fish and Crabs from Commencement Bay, Washington

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16. ABSTRACT

Information was collected to provide the Tacoma-Pierce County Health Department with chemical data needed to begin a preliminary assessment of any health risk possibly faced by persons eating fish and crabs from Commencement Bay and adjacent waters.

Sampling was conducted from July 1981 to January 1982. Eighty-six non-salmonid fish and six Dungeness crabs were collected from popular sport fishing locations in the vicinity of Commencement Bay and from a remote reference area, Discovery Bay. Muscle tissue from these specimens was chmeically analyzed for selected metals and organic compounds (EPA priority pollutnats).

Specimens from the Commencement Bay area generally had higher contaminant levels than did the specimens collected from Discovery Bay. The pollutant concentrations in the fish and crab varies considerably, depending on the species and their location. The highest concentrations of polychlorinated biphenyls (PCB's) and pesticides were measured in fish from the Hybelos Waterway, while the highest total metal concentrations measured in fish were found in flatfish from the Point Defiance dock. Regardless of where the crabs were collected, they contained total metal concentrations several times higher than the highest levels detected in fish.

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CHEMICAL CONTAMINANTS IN EDIBLE, NON-SALMONID FISH AND CRABS FROM COMMENCEMENT BAY, WASHINGTON

Environmental Services Division

Laboratory

U.S. Environmental Protection Agency

Region 10

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ABSTRACT

A survey of chemical contaminants in fish and crabs from Puget Sound's Commencement Bay area was initiated following reports by various agencies that certain waterways in the area contained relatively high levels of potentially toxic chemicals. Information was collected to provide the Tacoma-Pierce County Health Department with chemical data needed to begin a preliminary assessment of any health risk possibly faced by persons eating fish and crabs from Commencement Bay and adjacent waters.

Sampling was conducted from July 1981 to January 1982. Eighty-six non-salmonid fish and six Dungeness crabs were collected from popular sport fishing locations in the vicinity of Commencement Bay and from a remote reference area, Discovery Bay. Muscle tissue from these specimens was chemically analyzed for selected metals and organic compounds (EPA priority pollutants).

Specimens from the Commencement Bay area generally had higher contaminant levels than did the specimens collected from Discovery Bay. The pollutant concentrations in the fish and crabs varied considerably, depending on the species and their location. The highest concentrations of polychlorinated biphenyls (PCB's) and pesticides were measured in fish from the Hylebos Waterway, while the highest total metal concentrations measured in fish were found in flatfish from the Point Defiance Dock. Regardless of where the crabs were collected, they contained total metal concentrations several times higher than the highest levels detected in fish.

The mercury, PCB, and DDT concentrations measured were always well below the tolerance or action levels established by the U.S. Food and Drug Administration (FDA). However, few specific guidelines are available to assist in the direct assessment of the potential toxicity of many individual chemicals detected. The existing guidelines also do not address possible combinations of chemicals and metabolites. No attempt was made in this report to conduct an overall assessment based on these data.

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SCOPE OF STUDY

The purpose of this survey was to identify and measure potentially toxic metals and organic compounds in edible fish and crabs caught in the Commencement Bay area. This information was collected to assist Tacoma-Pierce County health officials in determining the health risks associated with the public's consumption of fish and crabs from Commencement Bay and adjacent waters.

The 114 organic compounds and 13 metals searched for during this survey are EPA's "priority pollutants". Because polychlorinated butadienes (PCBD's) had previously been found in Hylebos Waterway sediment, they were also searched for. The occurrences and concentrations of these toxics in Commencement Bay fish and crabs were to be compared with the levels found in fish and crabs from the reference station at Discovery Bay. Discovery Bay is located in the northern Puget Sound area, and is considered to be relatively free of chemical contamination.

Since the objective was primarily to search for chemicals on EPA's priority pollutant list, the analytical procedures followed current EPA practices. These practices did not provide detection levels as low as procedures designed especially for the isolation and determination of specific groups of compounds, like the polycyclic aromatic hydrocarbons.

Very little is known concerning the metabolites of the priority pollutants. Therefore, no effort was made to identify or search for them during this survey.

CONCLUSIONS

The edible muscle tissues of most of the fish and crabs collected contained several potentially toxic chemical contaminants. The degree of contamination varied considerably, depending on the species and the location from which the specimens were collected. Specimens from the Commencement Bay area generally had higher contaminant levels than did specimens from the Discovery Bay reference site.

The highest total metal concentrations measured in fish were found in "bottom" fish from the Point Defiance Dock. Total metal concentrations in "off-bottom" fish from the Commencement Bay area were similar to those measured in "off-bottom" fish from the Discovery Bay reference area. Crabs from both the Commencement Bay area and Discovery Bay contained total metal concentrations that were substantially higher than levels measured in fish from the same sites. The levels of mercury measured were always well below the action level of 1.0 ppm established by the FDA for fish and shellfish.

Fish taken from the Hylebos Waterway contained the highest concentrations of PCB's averaging approximately 0.5 ug/g wet weight, or about one-tenth the FDA tolerance level of 5.0 ppm, and one-fourth the proposed tolerance level of 2.0 ppm.

No chlorinated butadienes were found in any of the specimens at the limit of detection reached in this study. However, hexachlorobenzene (HCB) was detected in fish and crabs from the Hylebos Waterway, but not in specimens collected at other locations. The chlorinated hydrocarbon pesticides DDT, DDD, and DDE were the only pesticides detected. These compounds were found in all but one of the fish and crab samples analyzed. Relatively high levels of one or more of these pesticides were detected in individual fish from both the Commencement Bay area and the Discovery Bay reference site. However, the highest average total pesticide level was measured in specimens from the Hylebos Waterway. Specimens from Discovery Bay had the lowest average total pesticide level. Concentrations of DDT and its metabolites never exceeded the FDA action level of 5.0 ppm in fish.

Phthalates were commonly found in many of the fish. In addition, a limited number of volatile organic compounds were detected in a few of the fish and crabs collected.

Although most of the contaminants detected in the edible muscle tissues appeared to be present at relatively low levels, efforts should continue to be directed at assessing their human health significance. The potential toxicity of combinations of these and other contaminants and their metabolites must be considered in the risk assessment process.

RECOMMENDATIONS

The data should be reviewed and statistically analyzed by health officials and toxicologists to assess the possible human health effects of individual and total contaminant levels in fish and crabs from the Commencement Bay area.

The presence of pentachloropropene as well as other unidentified halogenated compounds found in the Hylebos Waterway samples should be investigated further. "Off-bottom" fish from the Hylebos should be analyzed to determine whether pentachloropropene and the unidentified halogenated compounds are present in these fish. It will be necessary to obtain some of the propene derivative to further verify the mass spectrum.

While the sample size of the individual species caught was often small, the sample size of the broader categories, e.g., the "bottom" fish, may allow further statistical analyses to be performed. Hopefully, this could provide additional general information about contaminant uptake in these fish.

INTRODUCTION

The potential for Puget Sound and adjacent waters to be adversely affected by expanding urban and industrial development has been known for some time. However, the possible extent and nature of some of these effects were not recognized until recently. In 1980, the National Oceanic and Atmospheric Administration (NOAA), Office of Marine Pollution Assessment (OMPA), reported on studies which described the distribution and possible biological effects of selected chemical contaminants in Puget Sound (6,11). Water, suspended matter, sediments, and aquatic organisms collected from several locations in Puget Sound were found to have measureable concentrations of one or more of the following groups of chemicals: metals, polychlorinated biphenyls (PCB's), petroleum hydrocarbons, and chlorinated organic compounds. Selected waterways in the Commencement Bay area generally appeared to be the most polluted.

In addition to the chemical contaminants observed, some of the fish, crabs, shrimp, and clams collected from a few of the contaminated areas were found by Malins and his associates (6) to have a variety of lesions of the liver or other organs. These observations raised questions about not only the relationship between the chemical contaminants and the health of associated aquatic organisms, but also about the possible influence of these chemicals on the health of those persons eating the contaminated seafoods. Considering the general lack of chemical and toxicological information on the chemical contaminants present in edible portions of aquatic organisms inhabiting the Commencement Bay area, the Tacoma-Pierce County Health Department issued warnings advising people not to eat fish and shellfish caught in certain waterways. Since this work has been completed, Malins and his associates (7) have published chemical and biological data on livers taken from 85 fish throughout Puget Sound. They presented data on organic compounds in liver and muscle tissue from 13 fish caught in Commencement Bay. These included five English sole, five salmon, and three cod.

To provide more complete information on which to assess the human health significance of the chemical contamination described, EPA Region 10 initiated a chemical survey in July 1981, to determine if potentially toxic organic compounds and metals were present in edible muscle tissues of non-salmonid fish and crabs from Commencement Bay and nearby waters.

The synergistic or antagonistic effects of the contaminants and their metabolites found in the fish are generally unknown at the present time.

The effect of the cooking methods used by the public was not considered in this report.

METHODS

SAMPLING PROCEDURES

Because the results of this survey were to be used to help assess possible risks to human health, it was essential that samples be collected in a representative manner, and not chemically contaminated as a result of handling. The various phases of the sampling program are discussed below.

Selection of Sampling Stations

Fish and crab samples were collected for chemical analysis from several stations located in Commencement Bay and connecting waterways as well as from a reference area, Discovery Bay (Figure 1). The stations established in the Commencement Bay area were as follows:

1. Hylebos Waterway (Northwest of the 11th St. Bridge)

2. City Waterway (Totem Marina Dock)

3. Old Town Dock

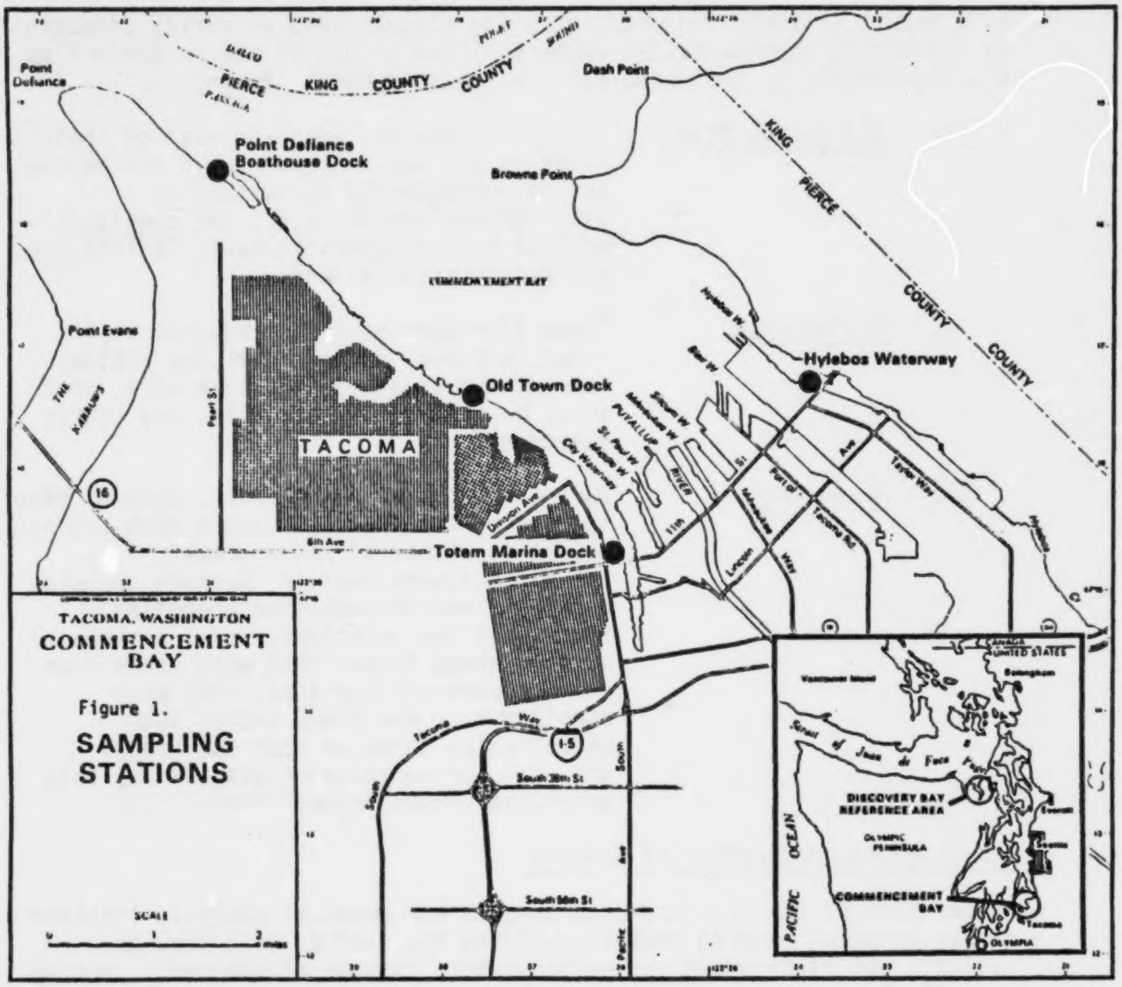
4. Point Defiance Dock

Hylebos Waterway was chosen as a sampling site because of the relatively high concentrations of organic compounds that previously had been detected in water, sediments,and aquatic organisms collected from that location (6,11). City Waterway (Totem Marina Dock), Old Town Dock, and the Point Defiance Dock were selected because of their popularity as public sport fishing sites (Personal Communication, Doug Pierce, Tacoma-Pierce County Health Department) as well as the representative coverage of the study area they provided. Crabs from the Commencement Bay area were collected only from popular sport crabbing locations - the Hylebos and City Waterways.

The selection of Discovery Bay as the reference, or background, area was based on considerations of its relative isolation from the more industrialized and developed areas of Puget Sound and the Strait of Juan de Fuca.

Collection of Samples

The 86 fish and 6 Dungeness crabs obtained in conjunction with this study were collected during the period from July 15, 1981 through January 7, 1982. Sampling at the Commencement Bay and waterway stations was conducted both during the day and at night using some of the same fishing techniques as those being used by sport fishermen in the area. Samples collected during the day were captured by hook and line as well as by an 18-foot beam trawl. Nighttime sampling was done with hook and line only. All but one of the samples collected from the Discovery Bay reference area were captured by commercial bottom trawlers fishing the northern and central portions of the Bay. One fish sample was collected during the day from the southern portion of the reference area using an 18-foot beam trawl.


Point Defiance
Point Defiance Boathouse Dock
Dash Point
Browns Point
PIERCE
KING
COUNTY
KING
PIERCE
COUNTY
COUNTY
COMMENCEMENT BAY
Point Evans
THE NARROWS
Pearl St
TACOMA
Old Town Dock
Hylebos Waterway
Hylebos W
Blair W
Sitcum W
Milwaukee W
PUYALLUP
RIVER
St Paul W
Middle W
City Waterway
Division Ave
6th Ave
Totem Marina Dock
11th
St
Port of
Tacoma Rd
Taylor Way
Lincoln
Milwaukee
Way
Ave
16
I-5
Tacoma
Way
South 38th St
South 56th St
South
South
Pacific
Ave
SCALE
0
1
2 miles
CANADA
UNITED STATES
Vancouver Island
Bellingham
Strait of Juan de Fuca
DISCOVERY BAY REFERENCE AREA
OLYMPIC PENINSULA
Everett
Seattle
PACIFIC OCEAN
COMMENCEMENT BAY
Tacoma
OLYMPIA

TACOMA, WASHINGTON
COMMENCEMENT BAY

Figure 1.

SAMPLING STATIONS

In conjunction with this survey, the Tacoma-Pierce County Health Department conducted a fish and crustaceancatch consumption study in the Commencement Bay area (10). Pacific hake and walleye pollock comprised 69.3% of the catch on a weight basis, with Pacific cod and Pacific tomcod contributing an additional 10.1%. The balance of the sport catch was made up of 33 species of fish that included members of such groups as the rockfish, flatfish, and perch.

As a result of these findings, sampling efforts were primarily directed at collecting representative numbers of two groups of non-salmonid fish distinguishable by their habitats and their general feeding habits:

1. Off-Bottom Fish — Those fish species spending most of their lives in the water column above the bottom, but not necessarily in surface or near-surface waters, i.e., the codfishes - walleye pollock, Pacific hake, Pacific cod, and Pacific tomcod, and;

2. Bottom Fish — Those fish species living most of their lives in direct contact with the bottom, i.e., the flatfishes - English sole, rock sole, C-O sole, flathead sole, and starry flounder.

3. Mixed Fish — During the course of sampling, several other species of fish were collected that did not belong to either of these groups, i.e., Pacific staghorn sculpin, buffalo sculpin, rockfish, and whitespotted greenling. Because of the relatively small numbers of most of these fishes that were taken from the Commencement Bay area, they were combined into one group rather than establishing three or four additional groups. For purposes of discussion, this group was termed "mixed" fish.

Handling and Preparation of Samples

Preparation of the fish and crab samples for chemical analysis involved a number of steps ranging from identifying the species collected to filleting or picking out the edible muscle tissues of interest. During each of these steps, emphasis was placed on preventing the samples from becoming chemically contaminated.

Initial Handling

As soon as possible after collection, the samples were wrapped in clean aluminum foil (Note 1) and placed in an ice chest containing several sealed polyethylene containers of ice. Upon returning to the laboratory, the samples were removed from the ice chest and stored at 1°C until the final phase of sample preparation could be initiated (Note 2). The only exception to this procedure involved the crab samples collected from the Hylebos and City Waterways. These samples were refrigerated at 1°C for several days then stored at -12°C for five months before thawing for final preparation.

Final Preparation

Before removing any tissues for analysis, each specimen was identified, weighed, measured, and inspected for grossly visible lesions, parasites, and other features of possible significance. Fish samples were first skinned (Note 3), then edible muscle tissue (the fillet) was removed from both sides of each specimen using stainless steel scalpels, scissors, and forceps (Note 4). As much edible muscle tissue as possible was picked from the crab samples using the same stainless steel instruments. The tissues collected were cut or torn into small pieces before being placed in glass jars having teflon-lined screw caps (Note 5), then weighed and stored at 1°C until processing for chemical analysis was begun.

Following the collection of the muscle tissues, fish livers were removed with stainless steel scissors and forceps, placed in glass jars fitted with aluminum foil-lined screw caps (Notes 1,5), and stored at -12°C for possible future chemical analysis. All the livers were weighed and visually inspected before being frozen.

Finally, the sex of the fish was confirmed by inspection of the gonads under a microscope, and otoliths were collected to provide information on the ages of the fish collected.

The gross visual inspection of the fish and livers for such things as lesions and parasites was included in the sampling procedures to compliment the chemical information being collected. These general observations were not intended to constitute an independent investigation of biological abnormalities. However, the observations were considered appropriate in light of recent studies identifying possible links between chemical contamination and diseases of fish and crustaceans from certain Puget Sound waters (6,7).

Notes:

1. The aluminum foil, used to line the tissue sample jar lids, and to wrap the whole fish and crabs, was cleaned in the following manner:

    a. Rinsed twice with pesticide-grade acetone.

    b. Rinsed twice with pesticide-grade methylene chloride.

    c. Dried 10 minutes in a drying oven at 100°C.

2. The decision to preserve the samples for analysis by refrigeration rather than freezing was based on concerns about the poorly defined effects of freezing, coupled with possible thawing and refreezing, on the concentrations of volatile organic compounds in edible muscle tissues. The procedure of analyzing refrigerated tissues was also believed to be consistent with the way in which many of the sport fish catches were preserved before being prepared for consumption.

3. Preliminary results of a survey of sport fishermen indicated that most of the non-salmonid fish caught in the Commencement Bay area were skinned either before or after being cooked, and the skins discarded (Personal Communication, Don Noviello, Tacoma-Pierce County Health Department). Consequently, the procedure of analyzing samples of muscle tissue that did not include the attached skin was adopted in an effort to provide the most realistic information possible on the chemicals actually being consumed by the public.

4. To prevent cross-contamination, all of the instruments used to collect the tissues of interest received the following cleaning treatment between the preparation of each sample:

   a. Washed with Liqui-Nox detergent, rinsed with tap water, then rinsed at least three times with distilled-demineralized water.

   b. Rinsed twice with acetone.

   c. Rinsed twice with methylene chloride.

   d. Dried for at least 10 minutes at 100°C and allowed to cool before using.

5. The glass jars and teflon lid liners, used for the storage of muscle and liver tissues, were cleaned using the following procedure:

   a. Washed with hot water and detergent.

   b. Rinsed with tap water.

   c. Rinsed with distilled water.

   d. Dried overnight in a drying oven at 350°C.

   e. Rinsed with pesticide-grade acetone.

   f. Rinsed with pesticide-grade methylene chloride.

   g. Air dried.

   The last rinses of acetone and methylene chloride were composited, concentrated, and checked for impurities by gas chromotography/electron capture (GC/EC).

ANALYTICAL METHODS

Fish and crab samples were analyzed for the priority pollutant organic compounds and metals, which are listed in Table E-1. Additional metals and organic compounds previously detected in Commencement Bay by other investigators were included. Tentative identifications were made for those compounds showing response in the gas chromatography/mass spectrometer (GC/MS) chromatograms.

Analytical methods for the priority pollutants, other organic compounds, and metals, followed EPA procedures as much as possible. However, modifications were needed to remove interferences so that lower detection limits were achievable. This section briefly outlines the procedures followed. Details of the procedures and detection limits are indicated in Tables F-3 and F-4.

Procedures for Organic Compounds

The edible muscle tissues of the fish and crab samples were extracted into a methylene chloride/methanol mixture three times with a Brinkman Polytron homogenizer. After filtering, the extracts were reduced in volume and combined with organic-free water at a pH of ≤ 2. The water/extract mixtures were extracted again with methylene chloride, reduced in volume and divided for pesticide/chlorinated hydrocarbon analysis and acid/neutral (A/N) analysis.

The fractions used for pesticide, PCB, and polychlorinated butadiene (PCBD) analyses were further cleaned on a Florisil column; pentane was used to elute the PCBD, PCB, and some of the chlorinated pesticide compounds. Mixtures of diethylether/pentane were used to elute the other pesticides. These fractions were analyzed by GC/EC (gas chromatography/electron capture) with dual column confirmation. When the concentrations of chlorinated species were sufficiently high, confirmation was obtained by a halogen - specific detector and/or fused silica capillary chromatography/mass spectrometry/data system (FSCC/MS/DS). The A/N fraction was further cleaned by gel permeation chromatography before FSCC/MS/DS analysis. Volatile organic compounds were analyzed by the gas purge, GC/MS procedure as modified by the Region 10 Laboratory (3). A detailed description of the analytial methods is presented in Appendix E.

Procedures for Metals

Samples of tissues were digested with a mixture of nitric acid and hydrogen peroxide until the tissue was destroyed. The metals were determined by atomic absorption spectrometry using a graphite furnace or flame following EPA methods (8). Mercury was determined by the manual cold vapor technique, similar to that described by EPA Method 245.5 (8).

RESULTS AND DISCUSSION

A total of 86 fish and 6 Dungeness crabs were collected for chemical analysis from the Commencement Bay stations and Discovery Bay.

The species composition of the fish and crab samples collected from each station is shown in Table 1. Other biological data such as age and physical measurements are tabulated in Table D-1.

Data for metals were obtained on all the fish and crab samples. All samples were analyzed for the volatile priority pollutants by GC/MS and scanned for the halogenated organic compounds by gas chromatography. Acid and neutral priority pollutants and additional organic compounds were determined in 49 samples. Results are discussed in terms of classes of compounds and metals found to be present in relationship to the numbers and types of fish taken from the various locations. Data are tabulated and presented in graphs in Appendices A through D. All averages are arithmetic means.

Polychlorinated Biphenyls (PCB's)

Aroclor 1254 was the only PCB measured in significant concentrations. PCB's were detected in every specimen analyzed. The range was from less than 0.010 micrograms per gram (ug/g) for most samples from Discovery Bay to 1.12 ug/g for a whitespotted greenling from the Hylebos Waterway. These concentrations are well below the 5.0 ppm tolerance for PCB's in the edible portion of fish and shellfish, as set by the U.S. Food and Drug Administration (FDA) (12).

The highest average concentration of PCB's at 0.55 and 0.62 ug/g wet weight were found in "bottom" and "mixed" fish respectively, taken from the Hylebos Waterway (Table 2). This was confirmed by GC/MS. Average PCB levels in "bottom" fish were from 2 to 4 times greater than the PCB concentrationsof the "off-bottom" fish at all of the stations in Commencement Bay. Unfortunately, no "off-bottom" fish were obtained from the Hylebos Waterway. However, PCB levels in "mixed" fish such as Pacific staghorn sculpin, buffalo sculpin, whitespotted greenling, and rockfish were highest in the Hylebos Waterway at an average of 0.62 ug/g. The PCB level was lowest, less than 0.010 ug/g, in the fish from the Discovery Bay reference station.

PCB levels in the "off-bottom" fish, such Pacific hake, Pacific tomcod, Pacific cod, and walleye pollock, were similarly low for all sampled stations, which may reflect the greater migratory tendency of these fish (Table 2). These "off-bottom" fish were not sampled in the Hylebos Waterway. However, PCB levels in the whitespotted greenling at this station were found to be the highest of any samples taken.

PCB levels in Dungeness crabs were much higher in samples taken from the Hylebos Waterway (0.052 ug/g) and City Waterway (0.068 ug/g) than in those taken from Discovery Bay (less than 0.010 ug/g). The PCB levels in the crab tissues were substantially lower than the levels in fish tissues from the same stations.

Table 1. Distribution of Fishes and Crabs from Commencement Bay, Adjacent Waterways, and the Discovery Bay Reference Area
July 15, 1982 - January 7, 1982

	Species	Hylebos Waterway	City Waterway (Totem Marina Dock)	Old Town Dock	Point Defiance Dock	Discovery Bay (Reference Area)	Totals
OFF-BOTTOM FISH	Walleye Pollock Theragra chalcogramma		5	5	5	5	20
	Pacific Hake Merluccius productus		5	5			10
	Pacific Tomcod Microgadus proximus		3			1	4
	Pacific Cod Gadus macrocephalus		2	1			3
BOTTOM FISH	English Sole Parophrys vetulus	5	5	3	3	5	21
	Rock Sole Lepidopsetta bilineata			2	3		5
	Flathead Sole Hippoglossoides elassodon				1	1	2
	Starry Flounder Platichthys stellatus			1		1	2
	C-O Sole Pleuronichthys coenosus				1		1
MIXED FISH	Pacific Staghorn Sculpin Leptocottus armatus	3		1	3	5	12
	Whitespotted Greenling Hexogrammos stelleri	3					3
	Buffalo Sculpin Enophrys bison			1	1		2
	Rockfish Sebastes sp.			1			1
CRAB	Dungeness Crab Cancer magister	2	2			2	6
	Rock Crab Cancer productus					1	1
	Totals	13	22	20	17	21	93

Table 2. Average PCB Concentrations* in Fish Muscle Tissue Sampled in the Commencement Bay Area and a Reference Station at Discovery Bay

	English Sole			Bottom Fishes			Off-Bottom Fishes			Mixed Fishes		
Station	Nd/Na	$\bar{X}$	Range	Nd/Na	$\bar{X}$	Range	Nd/Na	$\bar{X}$	Range	Nd/Na	$\bar{X}$	Range
Hylebos Waterway	5/5	0.55	0.13 - 1.03	5/5	0.55	0.13 - 1.03	0	-	-	5/5	0.62	0.17 - 1.1 2
Point Defiance Dock	3/3	0.33	0.10 - 0.64	6/6	0.22	0.060 - 0.64	5/5	0.058	0.017 - 0.13	4/4	0.040	0.011 - 0.052
City Waterway	5/5	0.19	0.054 - 0.36	7/7	0.17	0.033 - 0.36	14/14	0.086	0.017 - 0.53	0	-	-
Old Town Dock	3/3	0.12	0.091 - 0.16	5/5	0.12	0.091 - 0.16	11/11	0.058	0.017 - 0.14	3/3	0.066	0.032 - 0.010
Discovery Bay	2/5	<0.013	0.010_u - 0.017	3/7	0.012	0.010_u - 0.017	2/6	0.061	0.010_u - 0.27	0/5	0.010_u	-

* Concentrations expressed in ug/g wet weight
(Nd/Na) = No. of fish with detectable values/no. of fish analyzed
u = Value if any, is less than detection level

The average PCB concentrations in the various species of fish at the various sampling sites are depicted in Figures A-1 through A-14. Specific data are shown in Tables A-1 through A-3.

Chlorinated Butadienes (PCBD's)

Detectable levels of polychlorinated butadienes were not found in any of the muscle tissues analyzed. The limit of detection was 0.001 ug/g.

Hexachlorobenzene (HCB)

Hexachlorobenzene was detected only in fish and crab muscle tissue samples taken from the Hylebos Waterway. The HCB levels in the fish ranged from 0.014 ug/g to 0.15 ug/g with an average of 0.078 ug/g which was 2 to 6 times higher than in crab. The limit of detection for HCB by GC/EC was 0.001 ug/g. The presence of HCB in Hylebos Waterway samples was confirmed both with a halogen-specific detector and GC/MS.

Chlorinated Pesticides

Although a search was made for all of the chlorinated hydrocarbon pesticides listed in Table E-1, the only pesticides found were DDT, DDD and DDE. These three compounds were detected in all but one of the samples of fish and crab muscle tissue analyzed. Total pesticide levels (sum of the concentrations of DDT, DDD, and DDE) ranged from less than 0.001 ug/g to 0.059 ug/g, and were much lower than the PCB concentrations measured (Tables A-1, A-2, and A-3). The highest average total pesticide level was measured in species from the Hylebos Waterway, with specimens from Discovery Bay having the lowest average total pesticide level. Concentrations of DDT and its metabolites were always well below the FDA action level of 5.0 ppm.

Volatile, Acidic, and Neutral Organic Compounds

A variety of volatile, acidic, and neutral organic compounds were found by GC/MS in fish and crab muscle tissues taken from the five sampling stations. Although attempts were made to characterize several hundred compounds detected in tissue extracts by mass spectral matching techniques, only 56 compounds were identified. Comparision of retention times and mass spectra data generated from authentic substances was possible for 17 compounds found on the priority pollutant list. Tentative identifications based on mass spectral matching results were assigned to the remaining 43 substances. Both tetrachloroethylene and trichloroethylene were detected in fish tissue sampled at the Hylebos Waterway. Both chemicals were detected in water from the Hylebos in previous EPA surveys. This may be the first time volatile organics have been shown to accumulate in fish. The results of GC/MS analyses are compiled in Tables C-1, C-2, and C-3.

Several other unidentified chlorinated substances were present in all Hylebos Waterway tissue samples. These peaks were not present in samples taken from other stations.

Analysis of extracts of composited Hylebos English sole and crab by GC/halogen-specific detector and GC/MS confirmed the presence of chlorinated compounds. One unknown compound produced a mass spectrum similar to 1, 2, 3, 3-tetrachloro, -1-propene and another, a mass spectrum similar to that expected for pentachloropropene which is a strong mutagen (9). This latter mass spectrum was similar to that of the pentachloropropene detected in particulate extracts from Hylebos Waterway by Riley and associates (11). Reanalysis of an extract of an industrial effluent discharged to the Hylebos in 1979 showed the presence of a compound with the same mass spectrum and relative retention time as a chlorinated compound tentatively identified as pentachloropropene. This same tentatively identified compound was detected in fish collected from the Hylebos Waterway.

If the compound detected in the fish tissue, water, and particulate samples is pentachloropropene, an important link between discharge and biological uptake of a hazardous substance may be indicated.

Metals

The fish and crab tissue samples were analyzed for 13 metals. Arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc were found in low to moderate concentrations. Antimony, beryllium and thallium were not detected. All concentrations are presented on a wet weight basis.

The highest average total metal concentrations were found in the tissues of the "bottom" fish and the "mixed" fish. The "off-bottom" fish had lower average total metal concentrations regardless of station location.

"Bottom" fish had the highest average total metal concentration at the Point Defiance Dock station (27.6 ug/g). The average total metal concentrations in "bottom" fish at the other four stations are arrayed as follows: Hylebos Waterway 12.3 ug/g, Old Town Dock 11.4 ug/g, City Waterway 11.1 ug/g and Discovery Bay 9.4 ug/g (Figure B-1).

While "mixed" fish contained higher average total metal concentrations than did the "off-bottom" fish, there were no remarkable differences in "mixed" fish averages between stations. The highest average in this "mixed" fish category was in fish from the Old Town Dock area (12.8 ug/g). The second highest average was in fish from the Point Defiance Dock area (12.0 ug/g). The lowest averages in this group were found in fish from the Hylebos Waterway and Discovery Bay. "Mixed" fish from both of these areas had average total metal concentrations of 10.0 ug/g. No "mixed" fish were sampled at the City Waterway (Figure B-2).

The "off-bottom" fish had the lowest average total metal concentrations, and the smallest differences between these values at the different stations. "Off-bottom" fish from the Point Defiance Dock area actually contained less total metals, (8.4 ug/g) than did "off-bottom" fish from the reference station (8.5 ug/g). "Off-bottom" fish from the Old Town Dock area averaged 8.0 ug/g, and "off-bottom" fish from the City Waterway averaged 7.6 ug/g. Unfortunately no "off-bottom" fish from the Hylebos Waterway were sampled (Figure B-3).

Crab muscle tissues contained several times more total metal than the fish muscle tissues from the same sampling stations. Differences between station averages were small. The reference station Dungeness crab contained only slightly less total metal than did crab from the Hylebos Waterway (Figure B-14).

Total and individual metal concentrations found in the various fish and crab species are presented graphically in Figures B-4 through B-14. Averages of metal concentrations by species are compared in Table B-1 and the means and ranges by station are tabulated in Table B-2. Data describing metal concentrations for individual fish and crabs are presented in Table B-3.

The different metals are discussed individually with respect to station, species, and fish category occurrences.

(Fish Tissue)

Arsenic

Arsenic appeared in fish and crab tissues from all stations sampled. Fish containing relatively high levels of arsenic were caught near the Point Defiance Dock and at Discovery Bay.

English sole caught near the Point Defiance Dock averaged 8.6 ug/g arsenic. Rock sole caught at the same station averaged 16.2 ug/g. Five Pacific staghorn sculpins caught at Discovery Bay averaged 2.0 ug/g arsenic. A Pacific tomcod from Discovery Bay contained 3.4 ug/g arsenic.

Cadmium

Concentrations of cadmium in fish tissues were low from all sampling stations, usually below 0.01 ug/g. The Hylebos and City Waterways produced fish containing the highest levels. Fish from the Point Defiance Dock area and Discovery Bay contained the least cadmium.

All three Pacific staghorn sculpins caught in the Hylebos Waterway contained cadmium levels greater than 0.01 ug/g. The average cadmium level in these fish was 0.021 ug/g. Five of the eleven fish caught at the Hylebos Waterway contained more than 0.01 ug/g cadmium.

All "off-bottom" fish sampled from the City Waterway, with the exception of one Pacific tomcod, contained levels of cadmium greater than 0.01 ug/g. The average concentration in these "off-bottom" fish was 0.014 ug/g. "Bottom" fish caught in the City Waterway always contained less than 0.01 ug/g cadmium.

Chromium

Chromium levels were generally low in fish tissue from all stations. Stations producing fish with the highest concentrations of chromium were: the Hylebos Waterway where 64 % of the fish contained concentrations greater than 0.2 ug/g, the City Waterway were 41 % of the fish contained greater than or equal to 0.2 ug/g, and the Point Defiance Dock area where 38 % of the fish contained greater than or equal to 0.2 ug/g. The stations producing fish with the lowest levels of chromium were the Old Town Dock area and Discovery Bay.

At the Hylebos Waterway, all the "mixed" fish and one English sole contained chromium levels 0.2 ug/g. The "mixed" fish there averaged 0.41 ug/g chromium.

The "bottom" fish and two "off-bottom" fish from the City Waterway contained chromium levels ≥ 0.2 ug/g. "Bottom" fish from the City Waterway contained an average of 0.33 ug/g chromium.

At the Point Defiance Dock area, "bottom" fish contained a higher average level of chromium (0.25 ug/g) than did the "mixed" fish (0.13 ug/g) or the "off-bottom" fish (0.11 ug/g).

Copper

Copper concentrations were relatively high in fish from the Point Defiance Dock area and the Old Town Dock area. Fish from Discovery Bay, and the Hylebos and City Waterways contained less copper.

"Off-bottom" fish from the Point Defiance Dock area contained the most copper of any group of fish from any station. Copper concentrations in these fish averaged 0.82 ug/g. "Mixed" fish from the Point Defiance Dock area had the second highest average concentration at 0.76 ug/g. "Mixed" fish from the Old Town Dock area had the third highest average concentration of copper at 0.6 ug/g, followed by "off-bottom" fish from that same station with an average of 0.52 ug/g.

"Mixed" and "off-bottom" fish consistently contained more copper on the average than the "bottom" fish collected from any of the sampling stations.

Lead

Lead levels were highest in fish caught in the Point Defiance Dock area, the Old Town Dock area, and the City Waterway. Lead levels were lower in fish from Discovery Bay and the Hylebos Waterway.

"Bottom" fish from the Point Defiance Dock area contained the highest average lead concentration at 1.98 ug/g. This average includes a concentration of 10.4 ug/g lead found in an English sole. If this sole were excluded as an outlier from the averaging, the average for this group would be 0.58 ug/g lead. The second highest lead concentrations were found in the "mixed" fish from the Old Town Dock area. They averaged 0.63 ug/g lead. "Off-bottom" fish from the Point Defiance Dock station were third highest in lead concentration with an average of 0.61 ug/g.

Average levels of lead detected in the Hylebos Waterway samples were actually lower than those averages found in Discovery Bay samples.

Mercury

The Hylebos Waterway and the Old Town Dock area produced fish with the highest average mercury concentrations. "Off-bottom" fish at Discovery Bay also contained relatively high concentrations.

The highest concentrations of mercury were found in whitespotted greenling caught in the Hylebos Waterway. The average mercury content of these fish was 0.17 ug/g. The second highest concentrations were found in "off-bottom" fish from the Old Town Dock area. These fish averaged 0.010 ug/g mercury. Walleye pollock caught at the Discovery Bay station also contained higher mercury concentrations with an average of 0.008 ug/g.

At all stations, where comparisons could be made, the "mixed" fish and the "off-bottom" fish contained higher average levels of mercury than the "bottom" fish. Levels of mercury measured were always below the action level of 1.0 ppm established by the FDA for fish and shellfish.

Nickel

Nickel concentrations were highest in fish from the Hylebos and City Waterways. Fish caught in Discovery Bay had the lowest average nickel concentration with the following exception. The Hylebos Waterway "mixed" fish had a lower average nickel concentration (0.17 ug/g) than "mixed" fish from Discovery Bay (0.26 ug/g).

English sole from the Hylebos Waterway contained consistently high nickel concentrations, relative to other fish from other stations. The average nickel concentration among these fish was 1.26 ug/g. The second highest concentration was found among English sole from the City Waterway. These fish averaged 0.65 ug/g nickel.

The "bottom" fish sampled always contained average nickel levels lower than did the "mixed" fish or the "off-bottom" fish, regardless of station.

Selenium

Selenium concentrations were low at all stations. The stations producing fish with quantifiable values of any interest were the Hylebos Waterway, the Point Defiance Dock area, and the Old Town Dock area.

An English sole from the Hylebos Waterway contained 0.38 ug/g selenium. This was the highest selenium value found in any of the fish. "Bottom" fish from the Point Defiance Dock area contained an average selenium concentration of 0.17 ug/g. "Mixed" and "bottom" fish from the Old Town Dock area contained selenium averages of 0.11 ug/g and 0.10 ug/g, respectively.

Silver

There was only one quantifiable silver value (0.009 ug/g) and this value was lower than the silver detection limit in most cases (0.01 ug/g).

Zinc

The highest zinc concentrations were found in fish from the Old Town Dock and the Point Defiance Dock areas. Discovery Bay produced "bottom" and "mixed" fish with lower average zinc concentrations than any of the other sampling stations.

"Mixed" fish from the Old Town Dock area contained the highest average zinc concentration at 10.27 ug/g. The second highest average zinc concentration was found in "mixed" fish from the Point Defiance Dock area (8.68 ug/g). "Bottom" fish from Point Defiance followed with an average zinc concentration of 8.24 ug/g.

"Off-bottom" fish contained approximately the same concentrations of zinc regardless of station. These fish also contained less zinc on the average than "mixed" fish at any sampling station.

(Crab Tissue)

Metal concentrations detected in Dungeness crabs, caught in the Hylebos and City Waterways and Discovery Bay, were generally high. Zinc, copper, nickel, and silver concentrations were especially high.

Zinc concentrations were consistently high in crabs from all stations (49.3 ug/g to 52.6 ug/g). These averages are 5 to 12 times higher than zinc concentrations found in the fish tissue. Commencement Bay crabs contained 3 to 4 times the copper (12.7 ug/g to 15.0 ug/g) that Discovery Bay crabs contained (4.3 ug/g).

Lead concentrations in crabs from Commencement Bay were twice as high (0.69 ug/g to 0.82 ug/g) as those found in Discovery Bay crabs (0.36 ug/g). Mercury and cadmium levels in crabs from Commencement Bay were similar to levels found in crabs from the reference station.

Arsenic and nickel concentrations in crabs from the Commencement Bay area were actually lower than concentrations detected in crabs from the reference station.

BIOLOGICAL OBSERVATIONS

Composition and Distribution of Samples

Although emphasis was placed on collecting representative numbers of flatfish and codfish, almost every specimen captured from the Commencement Bay stations, up to a limit of five specimens of each species of fish and two specimens of each species of crab per station, was kept for analysis. Consequently, Table 1 is indicative of the fish and crab species caught most frequently at these stations from late summer to mid-winter. English sole was the fish caught most frequently, with a total of 16 fish being taken by trawling from the four Commencement Bay stations. Walleye pollock, Pacific hake, and Pacific staghorn sculpins were the second, third, and fourth most commonly caught fishes, respectively. A total of 15 pollock, 10 hake, and 7 sculpins were caught by hook and line from four stations, with the pollock and hake being caught only at night. Dungeness crabs were captured by trawling from only the Hylebos Waterway and City Waterway stations. No effort was made to catch crabs from elsewhere in the Commencement Bay area.

The fact that no codfishes (walleye pollock, Pacific hake, Pacific cod, and Pacific tomcod) were listed as being collected from the Hylebos Waterway does not mean that these fish species did not inhabit that location from time to time. Because little or no sport fishing had been reported in the Hylebos Waterway (Personal Communication, Don Noviello, Tacoma-Pierce County Health Department), no concerted effort was made to collect codfish from that station. The analysis of samples collected from more popular fishing sites was considered to be more important.

The selection of the species collected from the Discovery Bay reference area was primarily dictated by those species caught at the Commencement Bay stations. As a result, the list of species shown as being collected from Discovery Bay is not indicative of the relative abundance of these species in the commercial trawl catches from that area.

Condition of Samples

General Condition

The external condition of the crabs appeared to be good with only one Dungeness crab missing a leg and another having a "scar" on its carapace. Although no tumor-like growths were seen on any of the fish samples, approximately 13% of all the fish collected were observed to have some type of external abnormal condition. The abnormalities appeared to have been caused by such things as disease, predation, parasitism, abrasion, or hook and line fishing. The abnormal conditions recorded are listed in Table D-1 and summarized below.

The erosion or loss of portions of various fins was observed in an English sole and a whitespotted greenling from Hylebos Waterway, in an English sole and a rock sole from the Point Defiance Dock, and in a walleye pollock from City Waterway. Hemorrhaging along the dorsal, anal, and caudal fins was seen in a starry flounder from City Waterway, while "raw looking" pink/red splotches were observed on the blind side of a flathead sole from the same area. An open tear was noted in the flesh along the caudal peduncle of a walleye pollock from City Waterway, with a bleeding wound observed on the caudal peduncle of a rock sole from the Point Defiance Dock. In addition, a buffalo sculpin from Old Town Dock was missing a portion of its left maxillary, and a starry flounder from Discovery Bay had small lesions on its blind side that appeared to be associated with the presence of crustacean parasites.

The highest incidences of abnormality were in fish from City Waterway (20%), Point Defiance Dock (19%), and Hylebos Waterway (18%). Only 6% of the fish from Old Town Dock and the Discovery Bay reference area were observed to have external abnormalities.

Abnormalities in the fish from the Commencement Bay stations were most prevalent in flatfish (60%), with the remainder of the abnormalities (40%) being observed in walleye pollock, whitespotted greenling, and buffalo sculpin.

Inspection of the fish livers did not result in the detection of any grossly visible lesions or abnormal growths. The most striking feature of the livers examined, however, was the wide variation in their coloration from station to station. For example, the livers of English sole collected from the Hylebos Waterway ranged in color from yellowish/brown to yellowish/beige with pink or red/brown splotches, while the livers of English sole taken from Discovery Bay ranged from pink/beige to gray/brown with gray/white splotches.

Although the significance of the color differences was not known, they may have been linked to such factors as size, age, sex, diet, or physiological state. It is also possible that in some cases they were associated with a degenerative condition, or the presence of microscopic lesions, as reported by Malins and his associates (6).

Parasites

As expected, a variety of fish parasites and other associated organisms were observed during the gross visual examination of a number of fish collected for analysis. Other than noting the presence of some of the more noticeable organisms (Table D-1), no detailed cause and effect studies were undertaken.

One of the most prominent fish parasites recorded was the bloodworm, *Philometra*. These parasitic nematodes may have been present in other species and in other tissues, however, they were observed under the skin, commonly along the base of the fins, in only English sole and rock sole (Table 3).

Table 3. Distribution of the Bloodworm, *Philometra*, in English Sole and Rock Sole from the Commencement Bay Area and the Discovery Bay Reference Station

Station	Species	Incidence of Infestation (Fish Parasitized/Fish Collected)
Hylebos Waterway	English Sole	(0/5)
City Waterway	English Sole	(1/5)
Old Town Dock	English Sole	(3/3)
	Rock Sole	(1/2)
Point Defiance Dock	English Sole	(2/3)
	Rock Sole	(2/3)
Discovery Bay	English Sole	(0/5)

The incidence of *Philometra* in English sole ranged from 0/5 in the Hylebos Waterway and Discovery Bay, to 3/3 at Old Town Dock.

Although the wide variation in the incidence of *Philometra* in flatfishes from the Commencement Bay area could not be explained, it was generally consistent with the variation observed by Amish (2) in English sole from other Puget Sound waters. In addition, the overall frequency of occurrence of *Philometra* in English sole from all the Commencement Bay stations (38%) was only slightly higher than that (32%) reported by Weitcamp and Schadt (13) in English sole caught during the winter from the same general area.

Size and Age of Samples

The estimated ages of the fish collected ranged from 1 year to 11 years, with most of the fish being from 3 years to 6 years of age. The average lengths and estimated ages of the most frequently collected fish species (English sole, walleye pollock, and Pacific hake) are presented in Table 4. For more detailed information on the length, age, total weight, fillet weight, liver weight, and sex of these and other fish collected refer to Table D-1.

The average length of the English sole collected ranged from 246 mm (Old Town Dock) to 289 mm (City Waterway). The average estimated ages of English sole collected from these same stations ranged from 3 years at Old Town Dock to 5 years at City Waterway. Walleye pollock ranged in length from an average of 333 mm (Old Town Dock) to an average of 409 mm (City Waterway); the average estimated age of these fish also ranged from 3 years to 5 years, respectively. The average length of Pacific hake collected from Old Town Dock was 435 mm, with specimens collected from City Waterway averaging 448 mm in length.

Regardless of the species listed in the table, the smallest (and youngest) fishes were collected from Old Town Dock, with the largest (and oldest) specimens being taken from City Waterway. Considering the small sample sizes involved (3-5 samples), it was not possible to explain this size and age distribution. It is important to note that although most of the fish species collected were not characterized by large differences in size or age, the differences that did exist could have accounted for at least some of the variation observed in the result of the chemical analyses.

No effort was made to estimate the ages of the crabs collected. The Dungeness crabs ranged in carapace width (excluding spines) from 118 mm (Hylebos Waterway, female) to 186 mm (Discovery Bay, male).

Table 4. Mean Lengths and Estimated Ages of Selected Fishes Collected from the Commencement Bay Area and The Discovery Bay Reference Station.

	Stations				
Species	Hylebos Waterway	City Waterway	Old Town Dock	Point Defiance Boathouse Dock	Discovery Bay
		(Mean Length,mm/Mean Estimated Age,^{a} yrs)			
English Sole	276/3.8^b	289/5.4	246/3.0	263/4.7	285/5^b
Walleye Pollock	c	409/4.8	333/3.0	335/4.2	391/4.2
Pacific Hake	c	448/-	435/-	c	c

a Ages estimated from otoliths.

b Mean estimated age based on only four of the five specimens collected.

c No specimens collected.

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APPENDIX A.

Comparison of Concentrations of PCB's and Pesticides Among Fish Species and Sampling Sites

NOTE: "u" denotes concentration is less than detection limit

"$\leq$" denotes quantifiable concentrations have been averaged together with "u" concentrations

For more information concerning detection limits see Appendix F page 115.

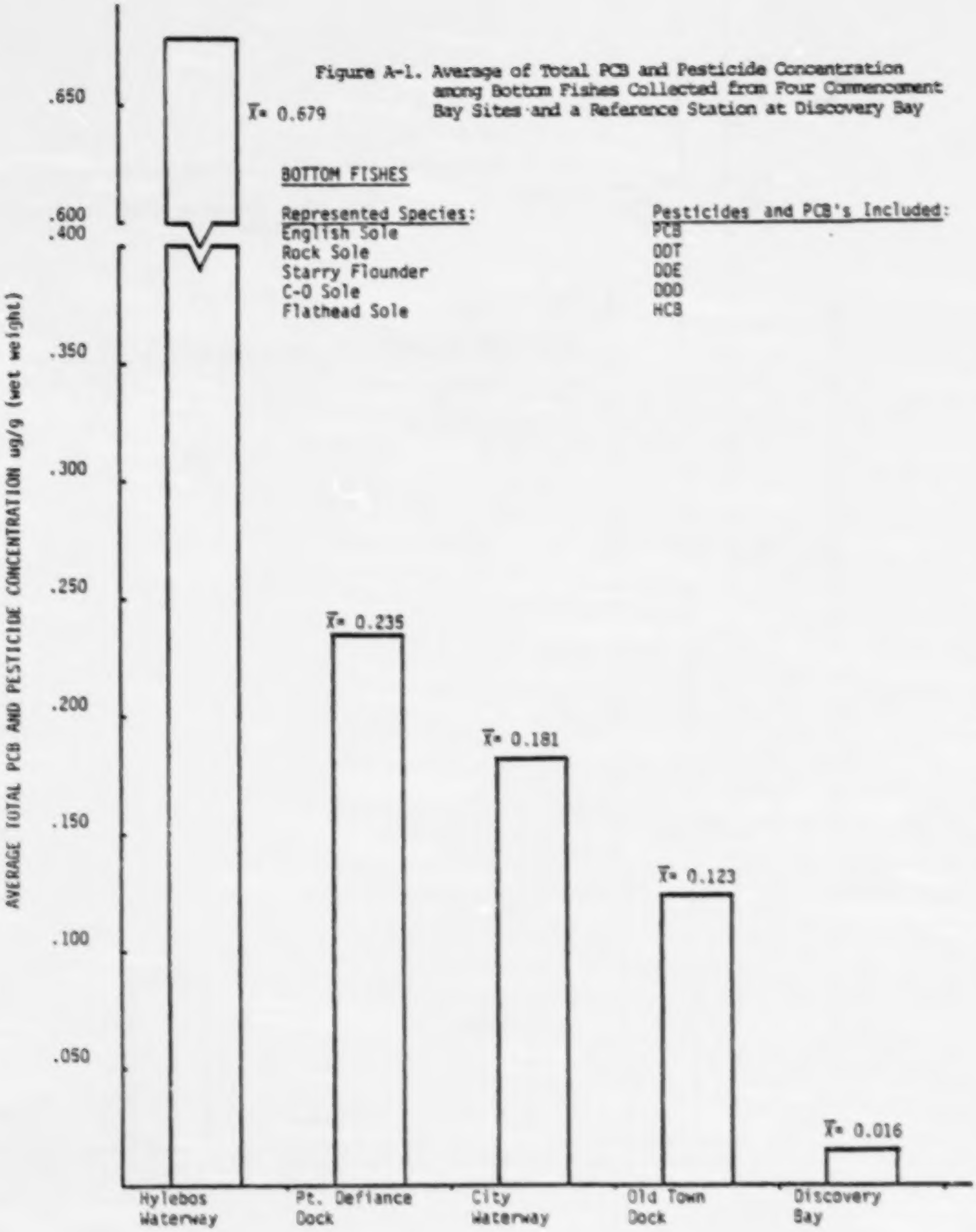


Figure A-1. Average of Total PCB and Pesticide Concentration among Bottom Fishes Collected from Four Commencement Bay Sites and a Reference Station at Discovery Bay

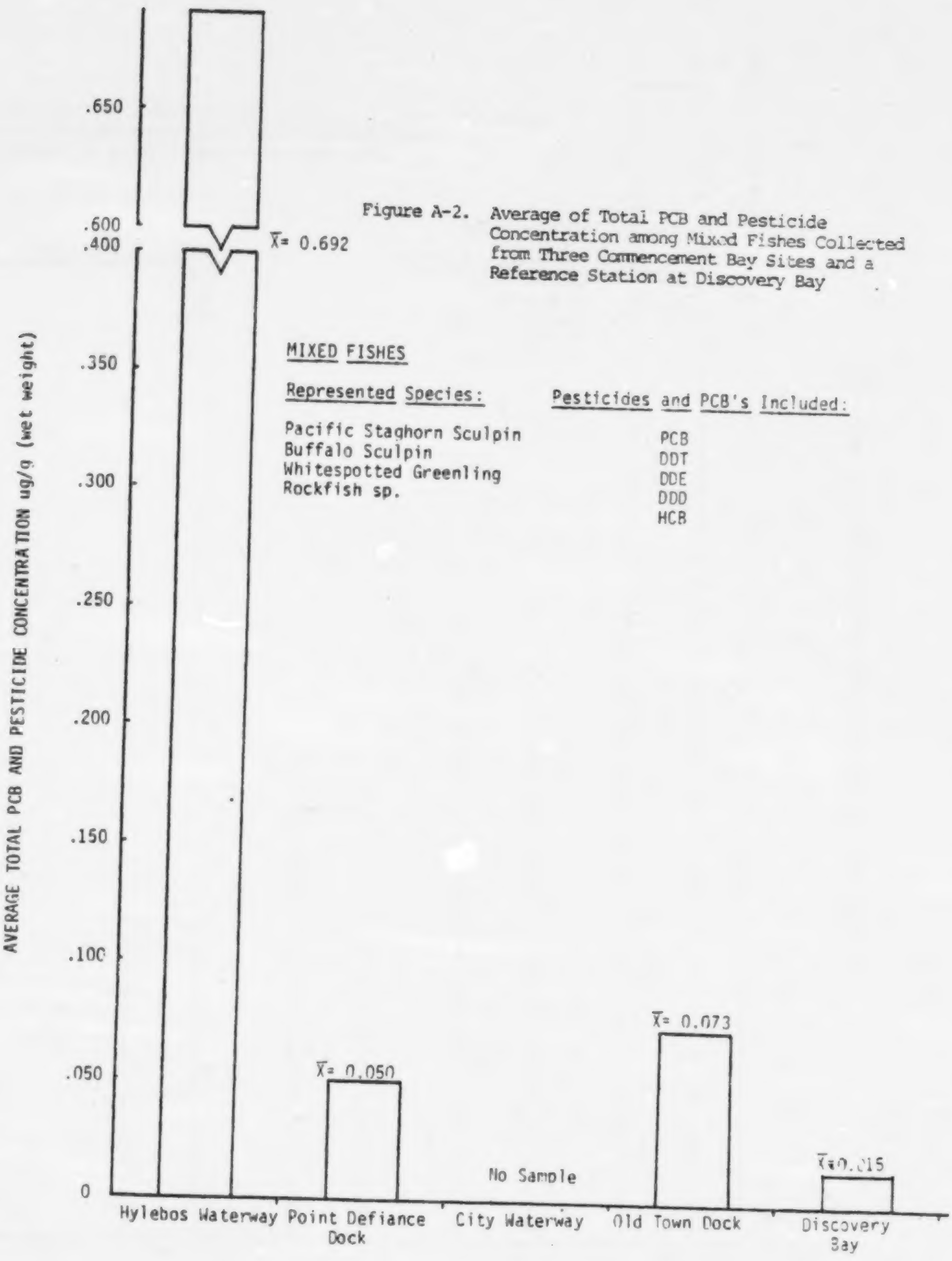


Figure A-2. Average of Total PCB and Pesticide Concentration among Mixed Fishes Collected from Three Commencement Bay Sites and a Reference Station at Discovery Bay

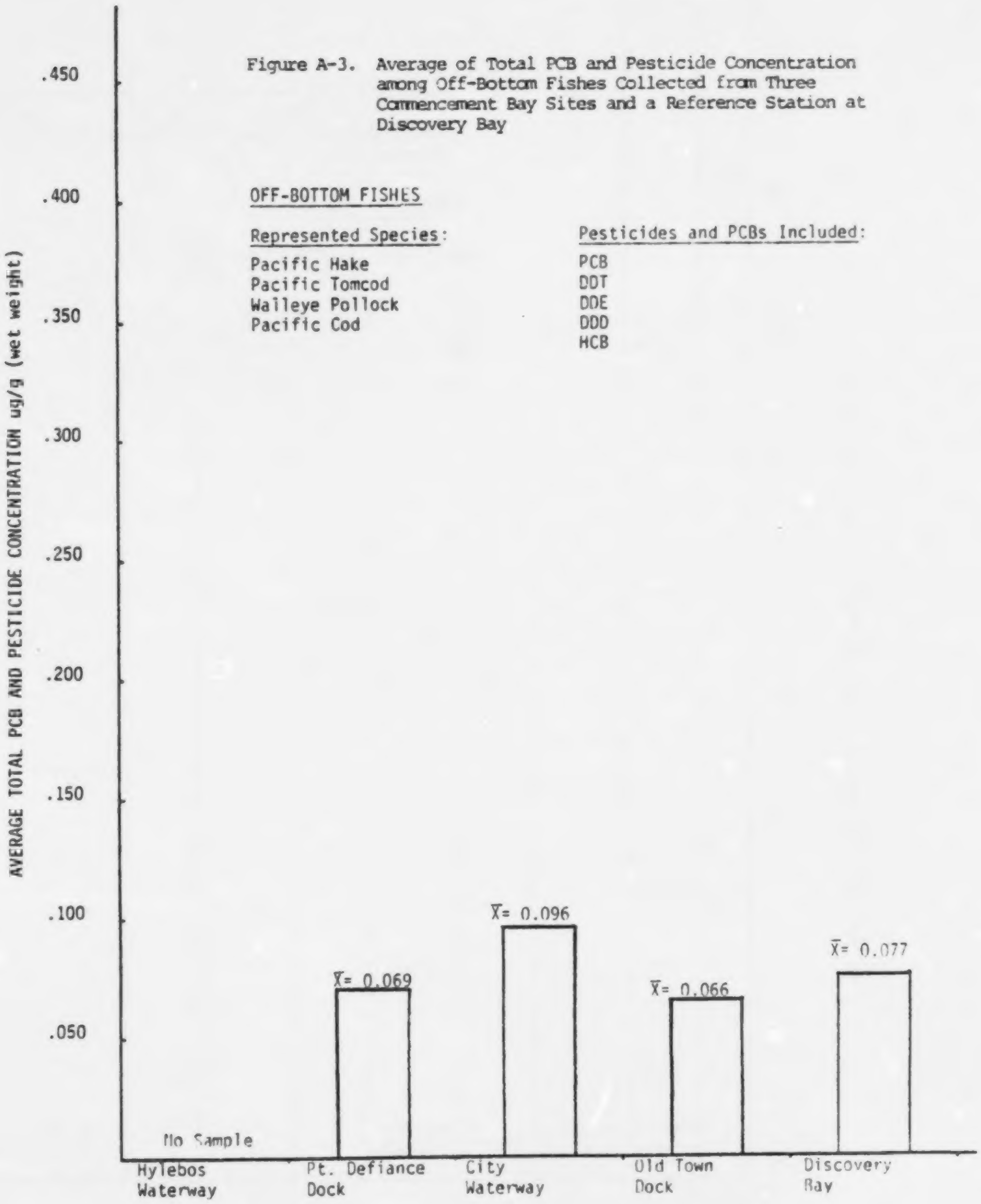


Figure A-3. Average of Total PCB and Pesticide Concentration among Off-Bottom Fishes Collected from Three Commencement Bay Sites and a Reference Station at Discovery Bay

OFF-BOTTOM FISHES

Represented Species:	Pesticides and PCBs Included:
Pacific Hake	PCB
Pacific Tomcod	DDT
Walleye Pollock	DDE
Pacific Cod	DDD
	HCB

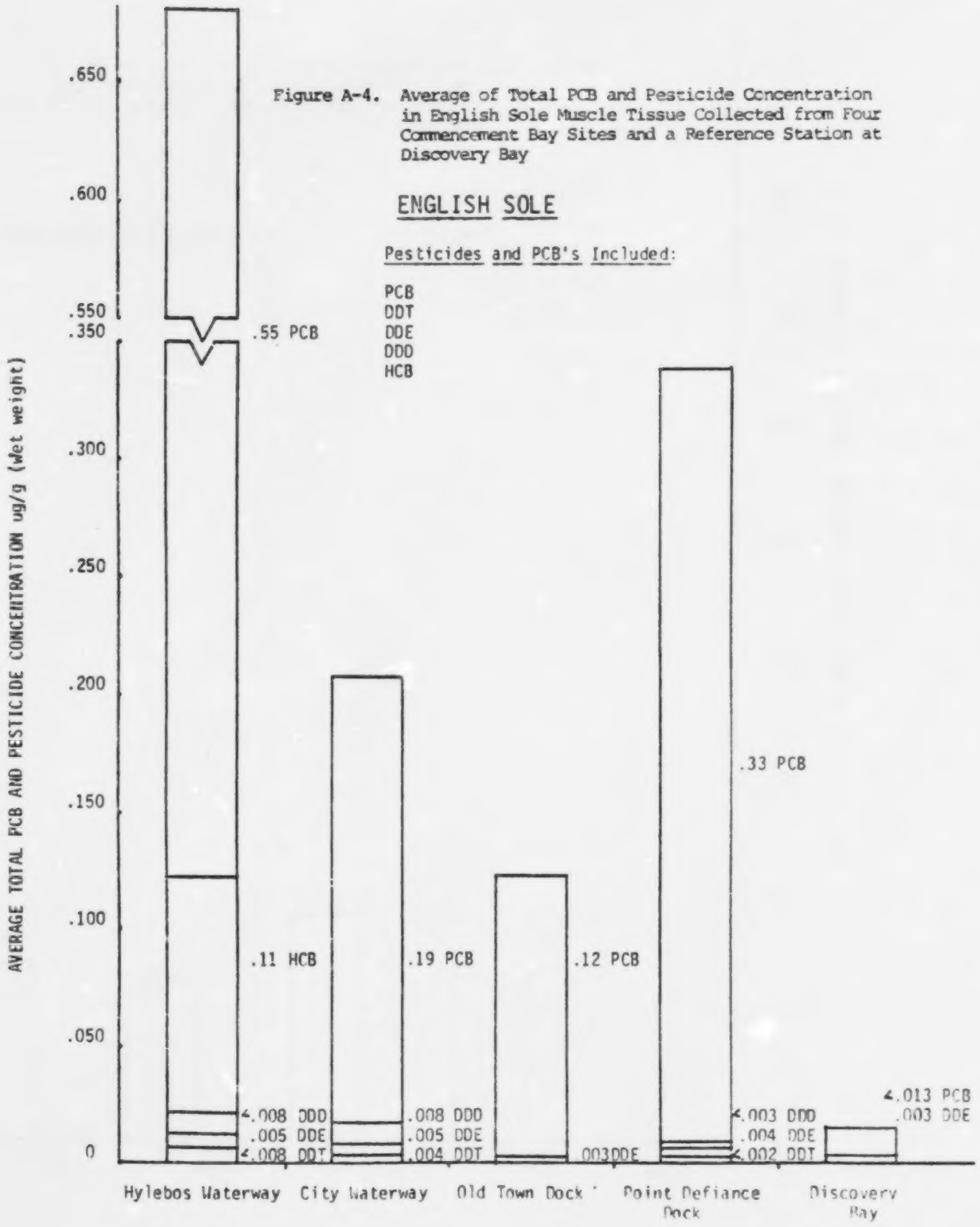


Figure A-4. Average of Total PCB and Pesticide Concentration in English Sole Muscle Tissue Collected from Four Commencement Bay Sites and a Reference Station at Discovery Bay

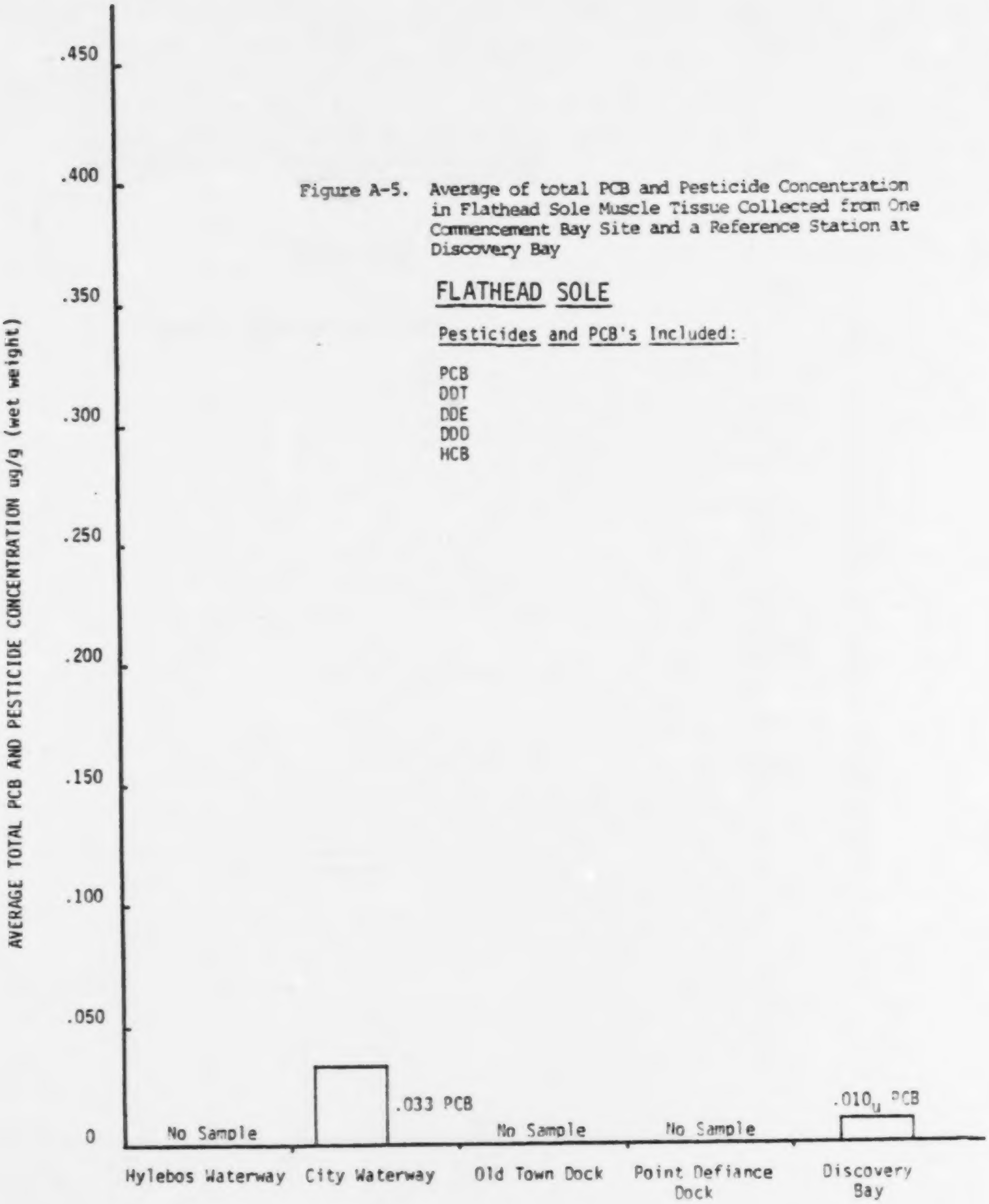


Figure A-5. Average of total PCB and Pesticide Concentration in Flathead Sole Muscle Tissue Collected from One Commencement Bay Site and a Reference Station at Discovery Bay

Figure A-6. Average of Total PCB and Pesticide Concentration in Rock Sole Muscle Tissue Collected from Two Commencement Bay Sites

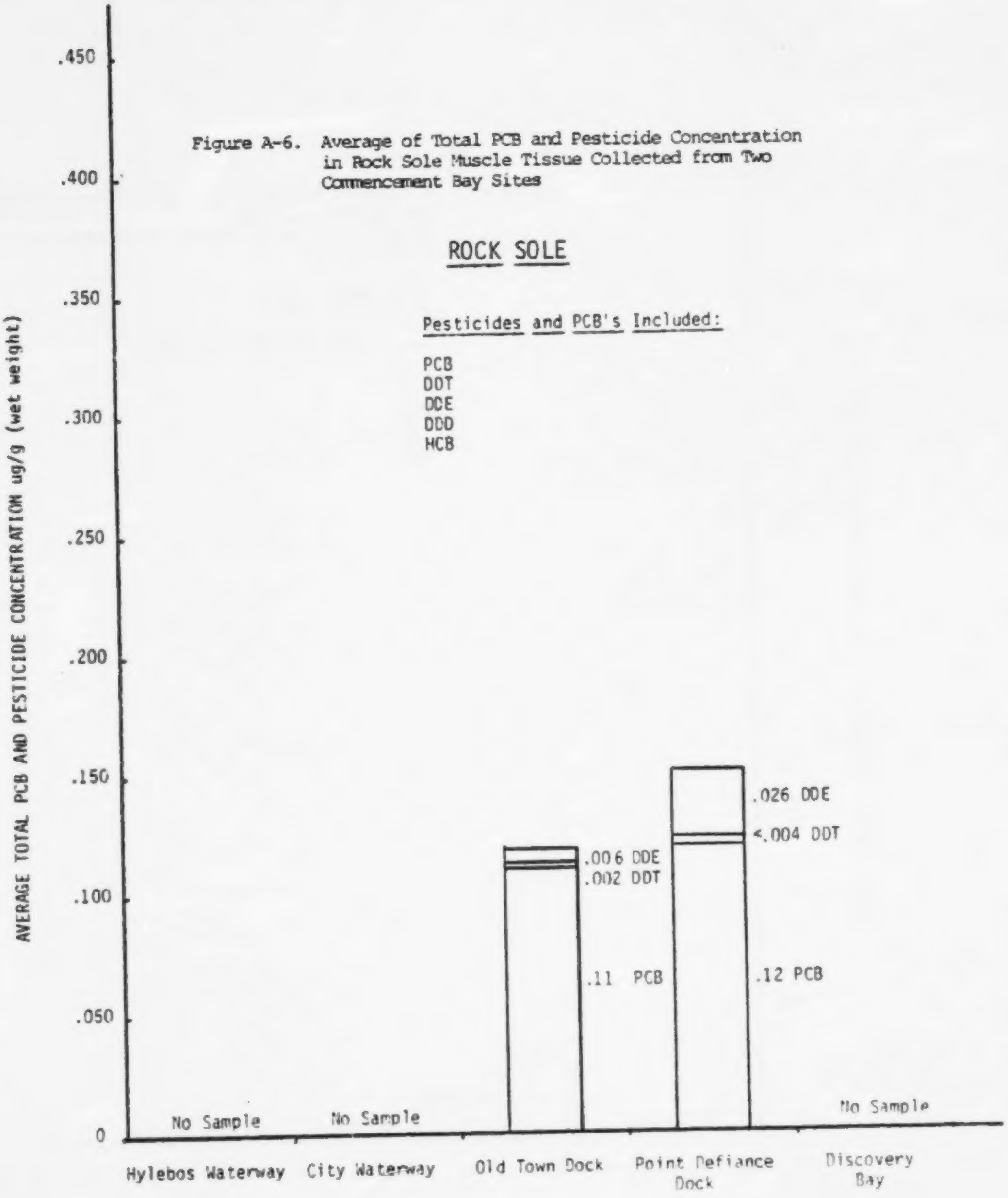
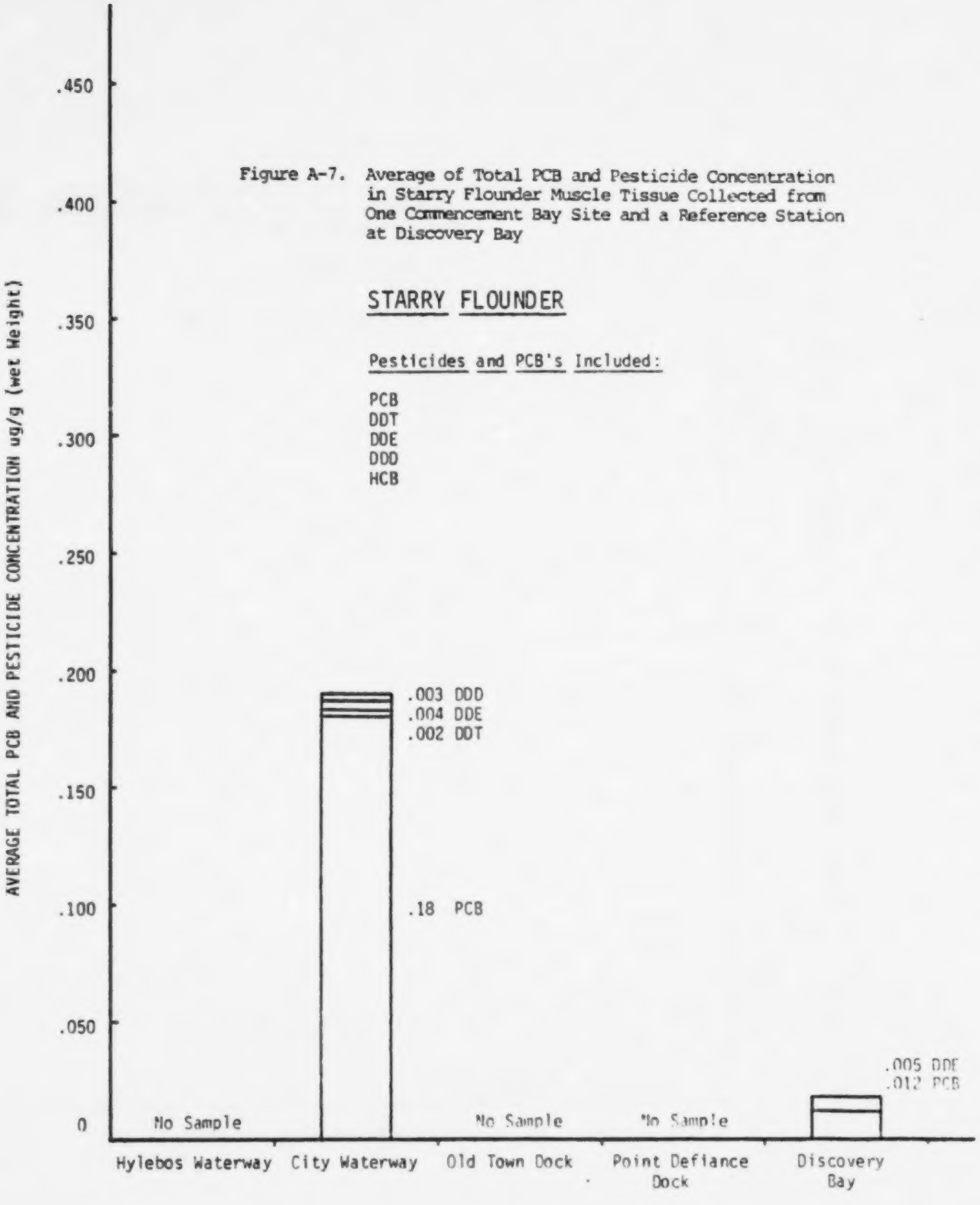


Figure A-7. Average of Total PCB and Pesticide Concentration in Starry Flounder Muscle Tissue Collected from One Commencement Bay Site and a Reference Station at Discovery Bay



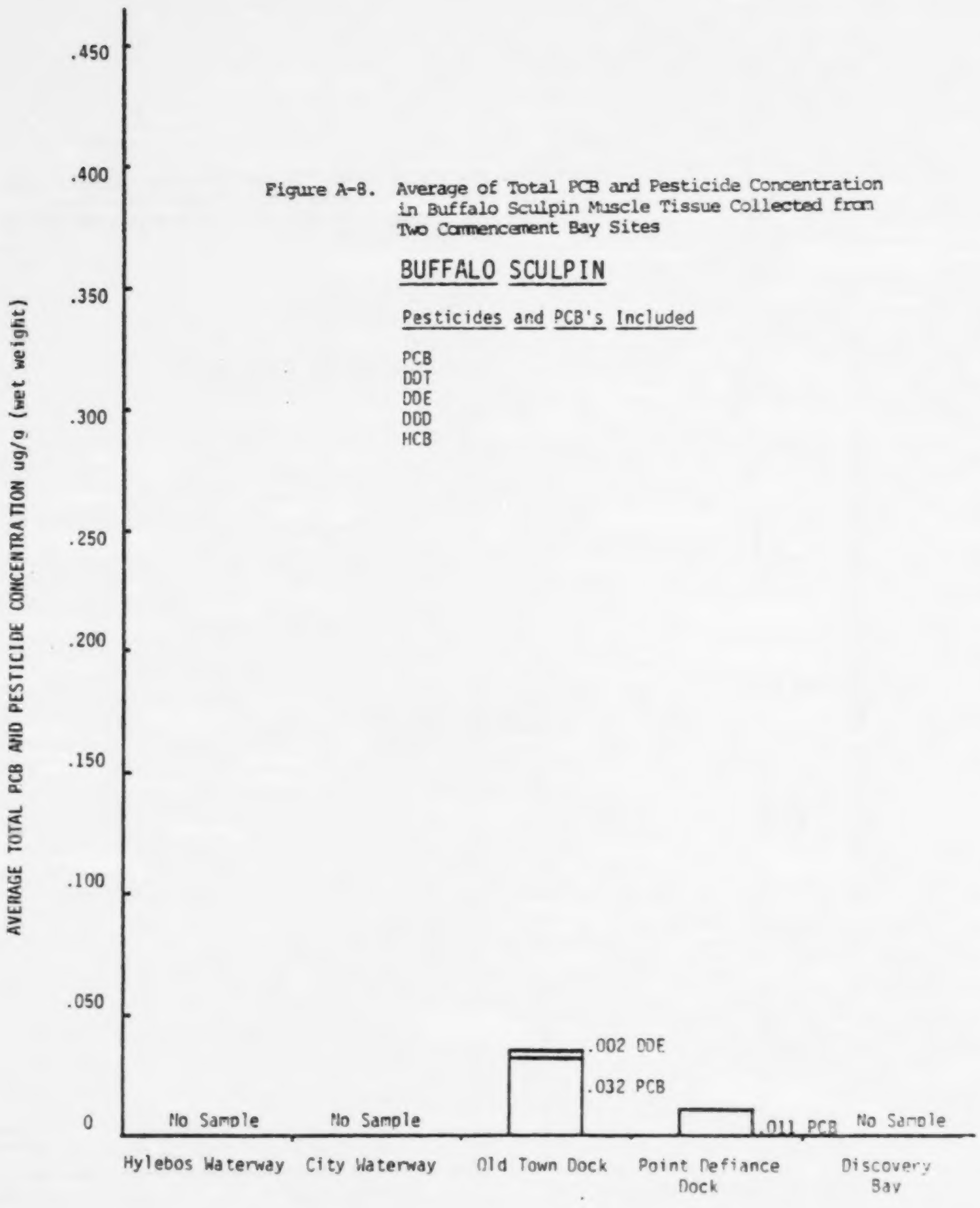


Figure A-8. Average of Total PCB and Pesticide Concentration in Buffalo Sculpin Muscle Tissue Collected from Two Commencement Bay Sites

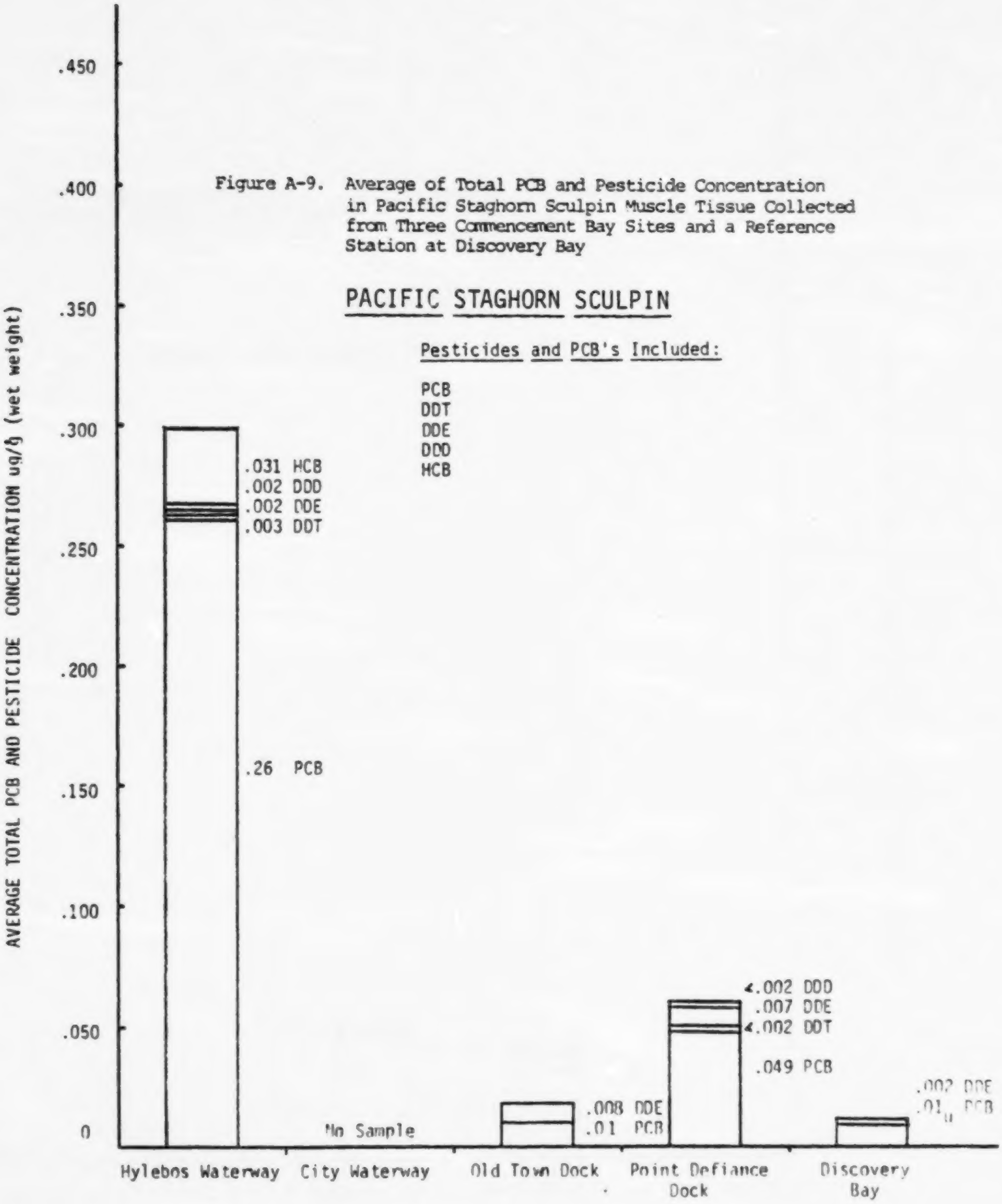


Figure A-9. Average of Total PCB and Pesticide Concentration in Pacific Staghorn Sculpin Muscle Tissue Collected from Three Commencement Bay Sites and a Reference Station at Discovery Bay

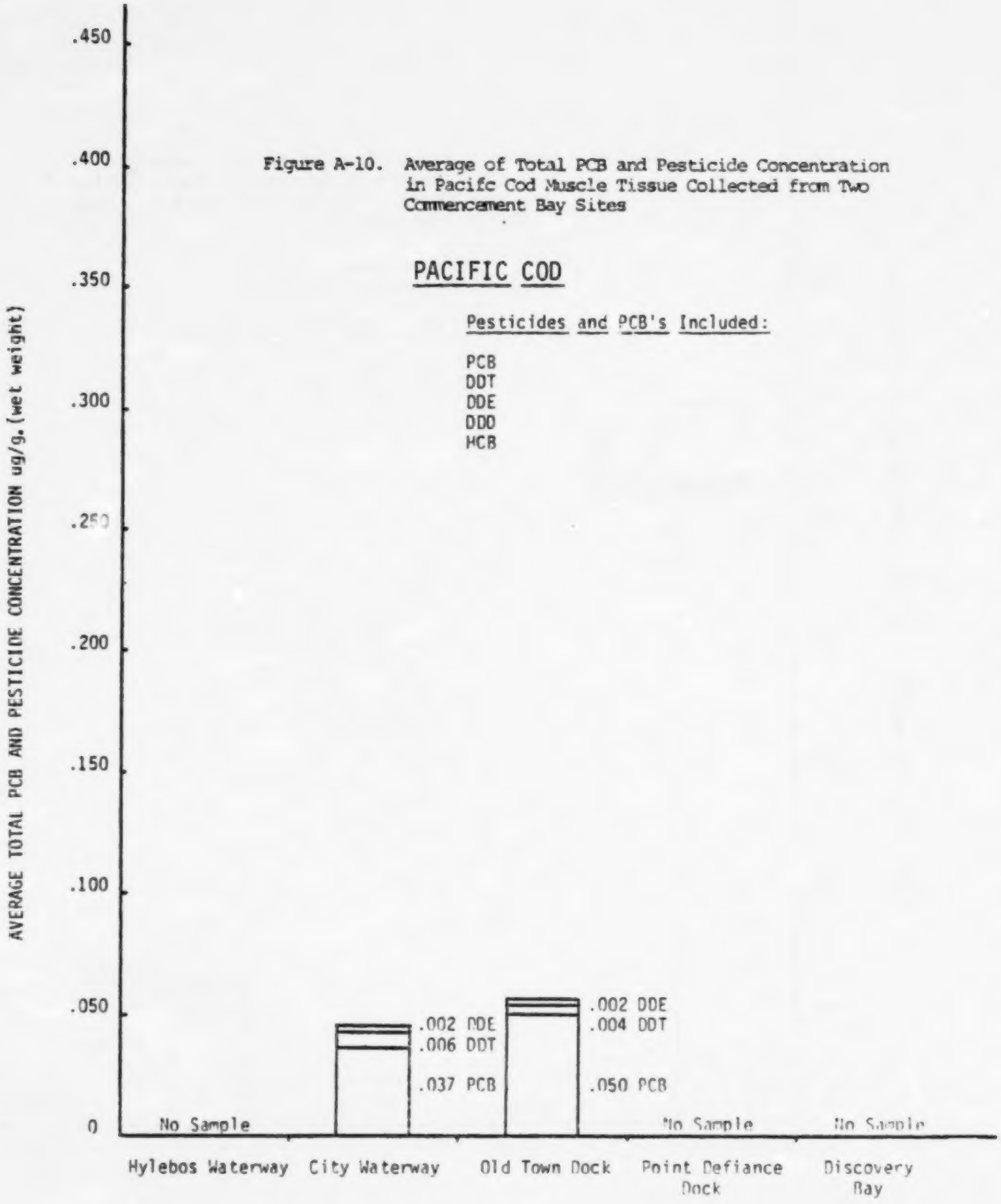


Figure A-10. Average of Total PCB and Pesticide Concentration in Pacifc Cod Muscle Tissue Collected from Two Commencement Bay Sites

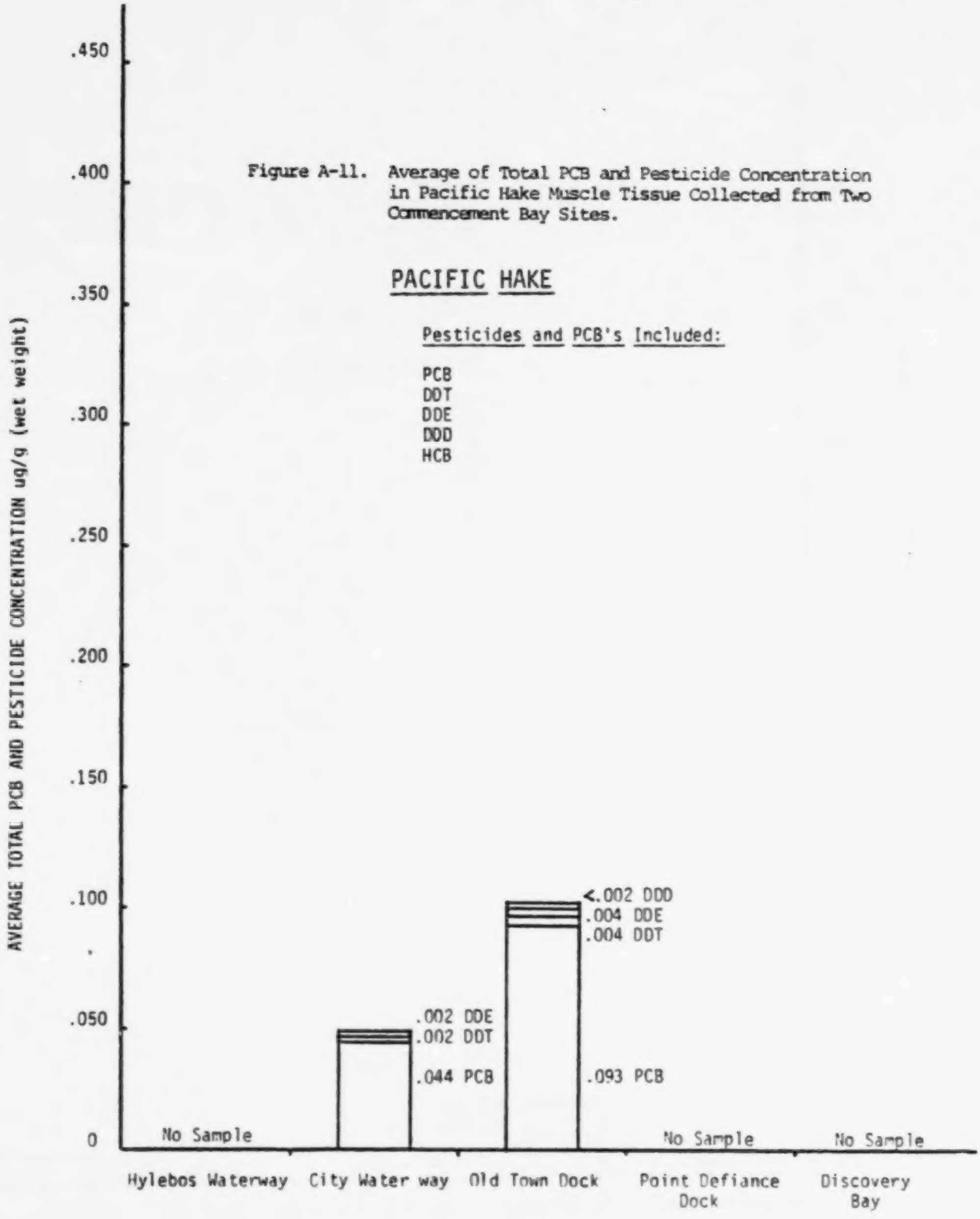


Figure A-11. Average of Total PCB and Pesticide Concentration in Pacific Hake Muscle Tissue Collected from Two Commencement Bay Sites.

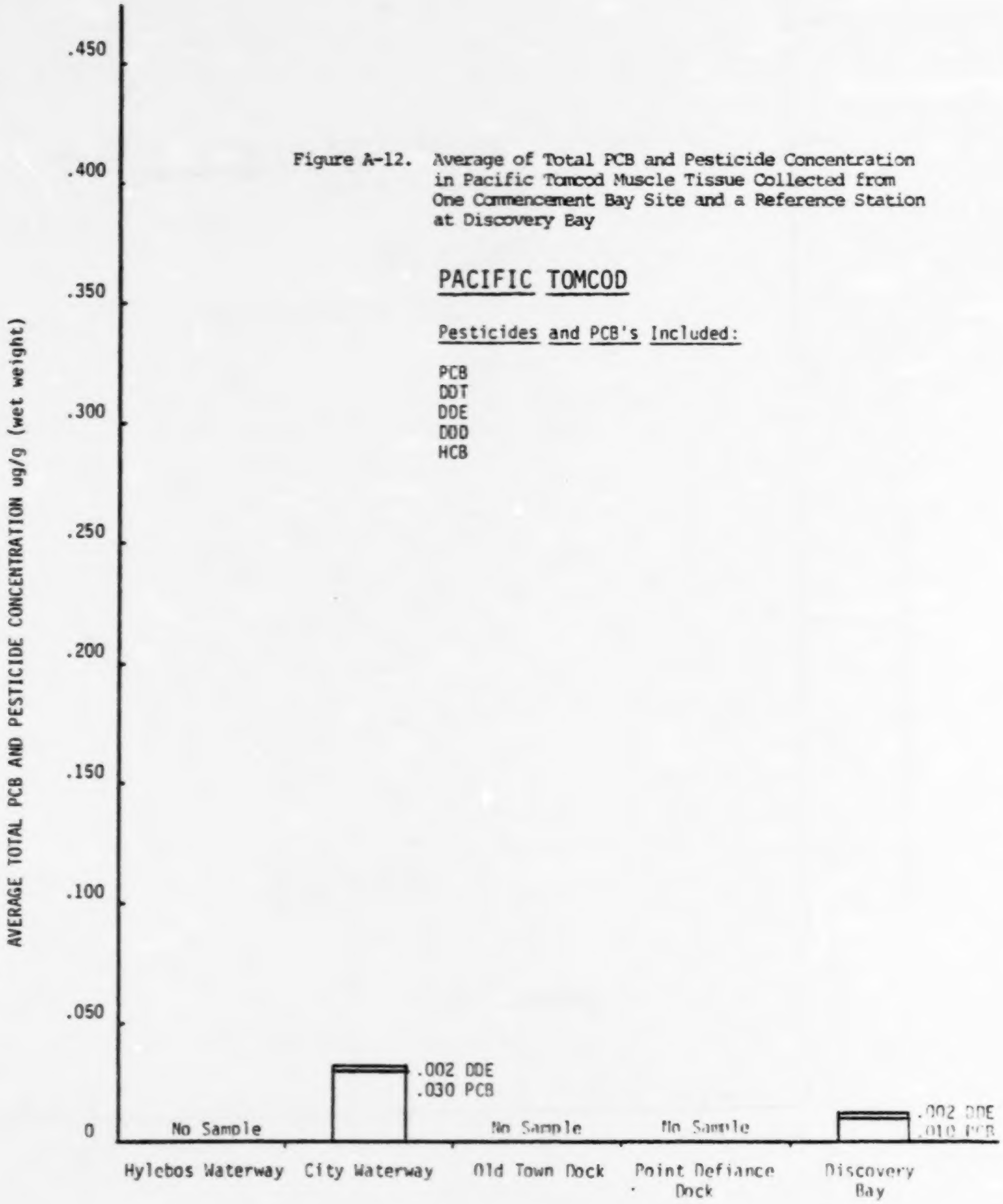


Figure A-12. Average of Total PCB and Pesticide Concentration in Pacific Tomcod Muscle Tissue Collected from One Commencement Bay Site and a Reference Station at Discovery Bay

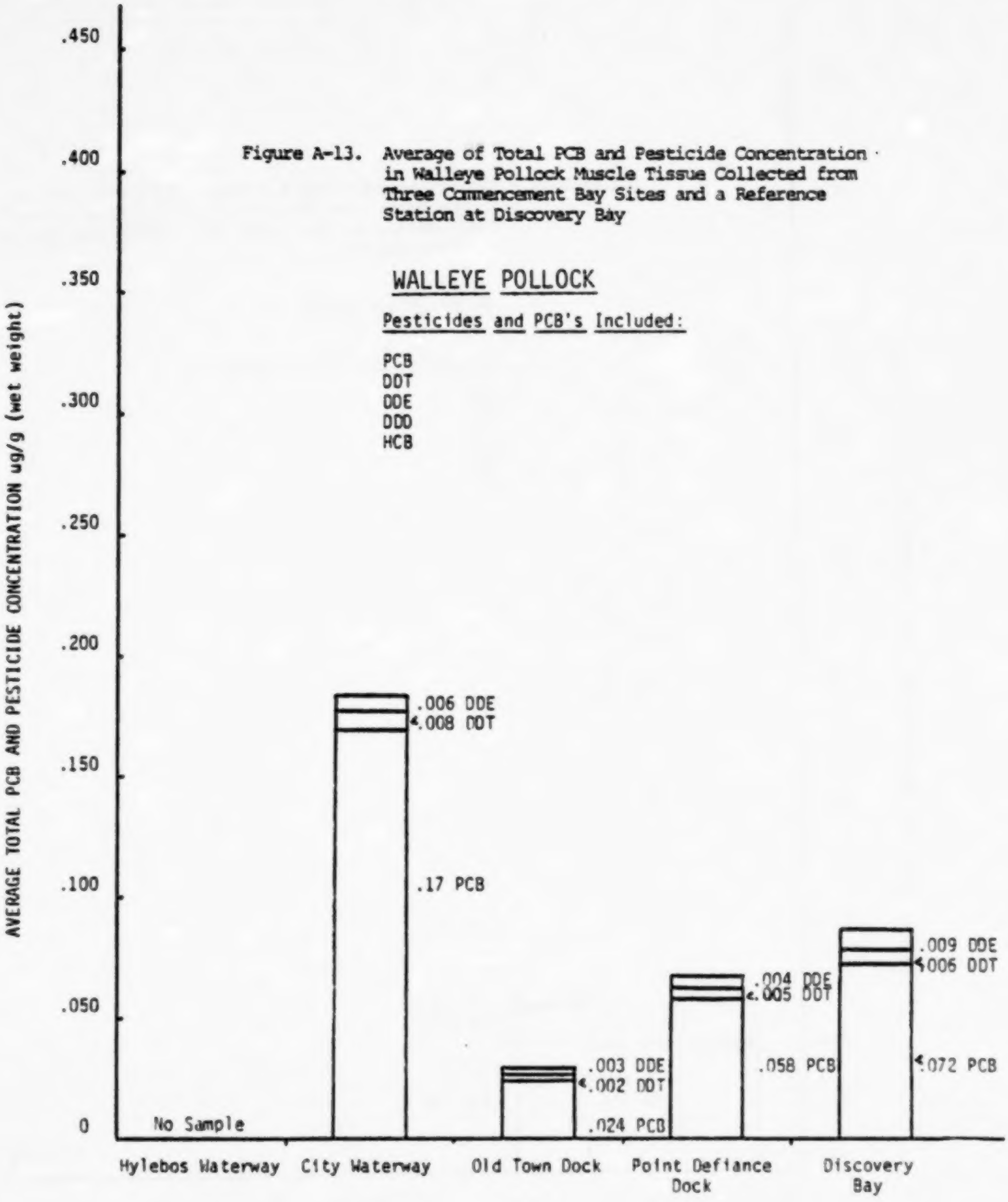


Figure A-13. Average of Total PCB and Pesticide Concentration in Walleye Pollock Muscle Tissue Collected from Three Commencement Bay Sites and a Reference Station at Discovery Bay

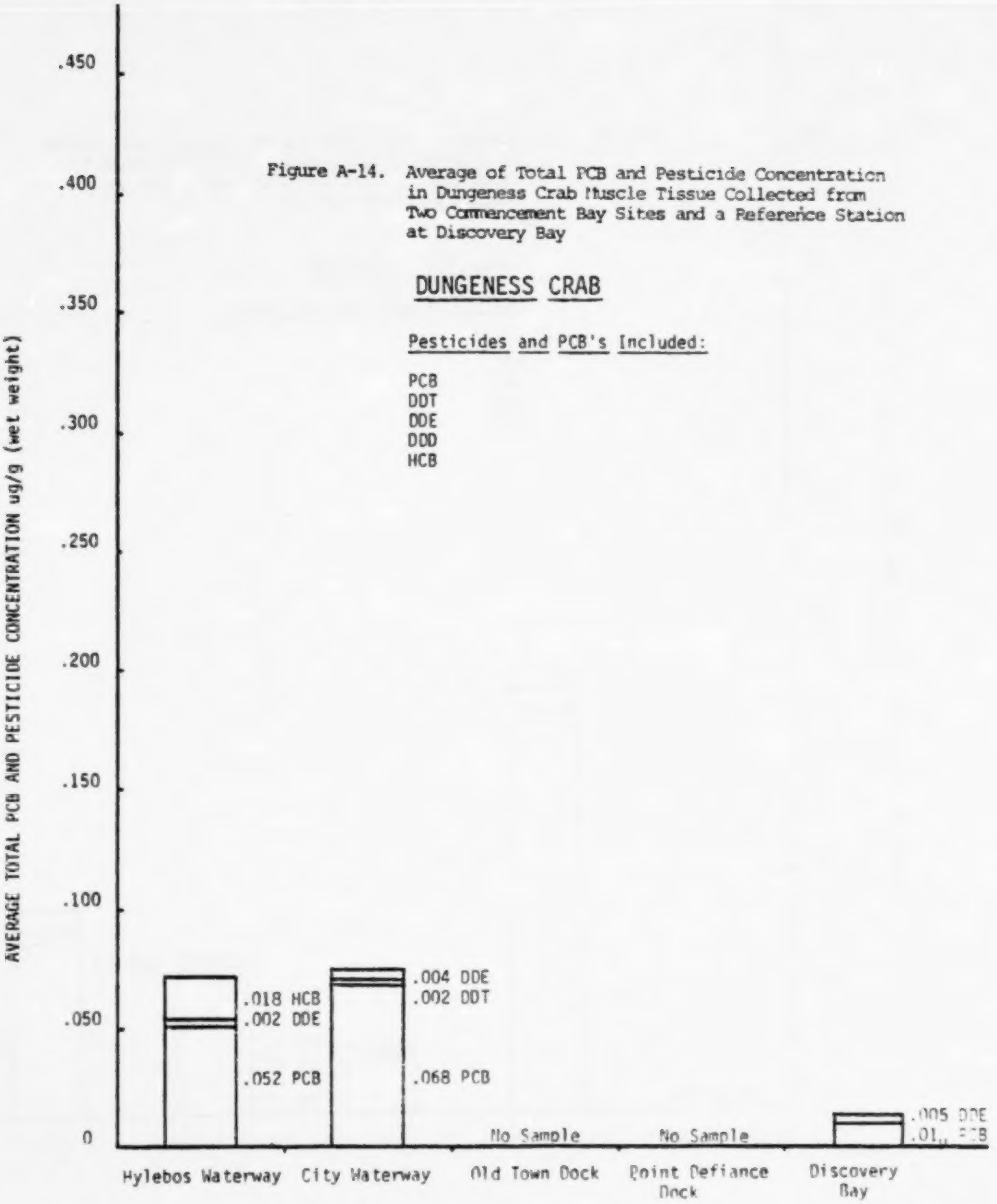


Figure A-14. Average of Total PCB and Pesticide Concentration in Dungeness Crab Muscle Tissue Collected from Two Commencement Bay Sites and a Reference Station at Discovery Bay

Table A-1.
Average PCB and Pestcide Concentrations Found in Fish Muscle Tissue Sampled in the Commencement Bay Area and Discovery Bay ug/g wet weight

			PCB		DDT		DDE		DDD		HCB	
Station	Species	(N)	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Hylebos	Whitespotted Greenling	3	0.86	0.45-1.12	0.025	0.014-0.037	0.006	0.002-0.01	0.005	0.002-0.01	0.059	0.014-0.096
Waterway	English Sole	5	0.55	0.13-1.03	<0.008 (4/5)	0.001u-0.015	0.005	0.002-0.007	<0.008(4/5)	0.001u-0.013	0.11	0.056-0.15
	Pacific Staghorn Sculpin	2	0.26	0.17-0.34	0.003	0.002-0.004	0.002	-	0.002	-	0.031	0.028-0.034
Point Defiance	English Sole	3	0.33	0.10-0.64	<0.002(1/3)	0.001u-0.005	0.004	0.003-0.005	<0.003(2/3)	0.001u-0.006	0.001u	-
Dock	Rock Sole	2	0.12	0.06-0.19	<0.004(1/2)	0.001u-0.006	0.026	0.003-0.049	<0.001(1/2)	0.001u-0.001	0.001u	-
	C-O Sole	1	0.07	-	0.001u	-	0.001	-	0.001u	-	0.001u	-
	Walleye Pollock	5	0.058	0.017-0.13	<0.005(2/5)	0.001u-0.015	0.004	0.001-0.011	<0.001(1/5)	0.001u-0.001	0.001u	-
	Pacific Staghorn Sculpin	3	0.049	0.045-0.052	<0.002(2/3)	0.001u-0.005	0.007	0.004-0.011	<0.002(2/3)	0.001u-0.003	0.001u	-
	Buffalo Sculpin	1	0.011	-	0.001u	-	0.001u	-	0.001u	-	0.001u	-

Fraction represents the number of samples with detectable values over the number of samples analyzed

Table A-1. cont.

Average PCB and Pesticide Concentrations Found in Fish Muscle Tissue Sampled in the Commencement Bay Area and Discovery Bay ug/g wet weight

			PCB		DDT		DDE		CDD		HCE	
Station	Species	(N)	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
City	English Sole	5	0.19	0.054-0.36	0.004	0.002-0.005	0.005	0.004-0.006	0.008	0.002-0.016	0.001u	-
Waterway	Starry Flounder	1	0.18	-	0.002	-	0.004	-	0.003	-	0.001u	-
	Walleye Pollock	5	0.17	0.017-0.53	<0.008(4/5)	.001u-0.026	0.006	0.002-0.015	<0.001(2/5)	0.001u-0.00	0.001u	-
	Pacific Hake	5	0.044	0.02-0.073	0.002	.002-0.003	0.002	0.001-0.003	<0.001(2/5)	0.001$_{u}$-0.002	0.001u	-
	Pacific Cod	2	0.037	0.036-0.038	0.006	0.001-0.011	0.002	0.001-0.002	0.001u	-	0.001u	-
	Flathead Sole	1	0.033	-	0.001u	-	0.001	-	0.001u	-	0.001u	-
	Pacific Tomcod	2	0.03	0.028-0.032	0.001u	-	0.002	0.002-0.003	0.001u	-	0.001u	-
Old Town	English Sole	3	0.12	0.091-0.16	0.001	0.001-0.002	0.003	0.002-0.003	<0.001(1/3)	0.001u-0.002	0.001u	-
Dock	Rock Sole	2	0.11	0.096-0.12	0.002	0.001-0.004	0.006	-	<0.001(1/2)	0.001u-0.001	0.001u	-
	Pacific Staghorn Sculpin	1	0.10	-	0.001	-	0.008	-	0.001u	-	0.001u	-
	Pacific Hake	5	0.093	0.05-0.14	0.004	0.001-0.006	0.004	0.002-0.008	<0.002(3/5)	0.001u-0.004	0.001u	-
	Rockfish	1	0.059	-	0.002	-	0.007	-	0.001u	-	0.001u	-
	Pacific Cod	1	0.05	-	0.004	-	0.002	-	0.001u	-	0.001u	-
	Buffalo Sculpin	1	0.032	-	0.001	-	0.002	-	0.001u	-	0.001u	-
	Walleye Pollock	5	0.024	0.017-0.033	<0.002(3/5)	0.001$_{u}$-0.002	0.003	0.002-0.003	0.001u	-	0.001u	-

Fraction represents the number of samples with detectable values over the number of samples analyzed

Table A-1. cont.

Average PCB and Pesticide Concentrations Found in Fish Muscle Tissue Sampled in the Commencement Bay Area and Discovery Bay ug/g wet weight

			PCB		DDT		DDE		DDD		HCB	
Station	Species	(N)	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Discovery Bay	Walleye Pollock	5	<0.072(2/5)	0.01u-0.27	<0.006(2/5)	0.001u-0.024	0.009	0.001-0.035	<0.001(1/5)	0.001u-0.002	0.001u	-
	English Sole	5	<0.013(2/5)	0.01u-0.017	<0.001(1/5)	0.001u-0.002	0.003	0.002-0.003	0.001u	-	0.001u	-
	Starry Flounder	1	0.012	-	0.001u	-	0.005	-	0.001u	-	0.001u	-
	Pacific Staghorn Sculpin	5	0.010u	-	0.001u	-	0.002	0.002-0.004	0.001u	-	0.001u	-
	Pacific Tomcod	1	0.010u	-	0.001u	-	0.002	-	0.001u	-	0.001u	-
	Flathead Sole	1	0.010u	-	0.001u	-	0.001	-	0.001u	-	0.001u	-

Fraction represents the number of samples with detectable values over the number of samples analyzed

Table A-2.
PCB and Pesticide Concentrations*Found in Fish Muscle Tissue Sampled at the Hylebos Waterway

Lab. No.	Species	PCB 1254	Average	DDT	Average	DDE	Average	DDD	Average	HCB	Average
36051	English Sole	0.88		0.007		0.006		0.010		0.14	
36052	English Sole	0.47		0.007		0.005		0.009		0.12	
36053	English Sole	0.13	0.55	0.001u	<0.008	0.002	0.005	0.001u	<0.008	0.056	0.11
36054	English Sole	0.25		0.008		0.003		0.007		0.069	
36055	English Sole	1.03		0.015		0.007		0.013		0.15	
44000	Whitespotted Greenling	1.12		0.037		0.010		0.010		0.096	
44001	Whitespotted Greenling	0.45	0.86	0.014	0.025	0.005	0.006	0.003	0.005	0.068	0.059
44002	Whitespotted Greenling	1.02		0.025		0.002		0.002		0.014	
44003	Pacific Staghorn Sculpin	0.34		0.002		0.002		0.002		0.028	
44004	Pacific Staghorn Sculpin	0.17	0.26	0.004	0.003	0.002	0.002	0.002	0.002	0.034	0.031
44005	Pacific Staghorn Sculpin	-	-	-	-	-	-	-	-	-	-

* Concentrations Expressed in ug/g Wet Weight

Table A-2.cont.
PCB and Pesticide Concentrations*Found in Fish Muscle Tissue Sampled at the City waterway .

Lab. No.	Species	PCB 1254	Average	DDT	Average	DDE	Average	DDD	Average	HCB	Average
29005	Pacific Tomcod	-	-	-	-	-	-	-	-	-	-
46051	Pacific Tomcod	0.032	0.030	0.001u	0.001u	0.002	0.002	0.001u	0.001u	0.001u	0.001u
46052	Pacific Tomcod	0.028		0.001u		0.003		0.001u		0.001u	
46050	Pacific Cod	0.038	0.037	0.001	0.006	0.001	0.002	0.001u	0.001u	0.001u	0.001u
46058	Pacific Cod	0.036		0.011		0.002		0.001u		0.001u	
38022	Starry Flounder	0.18	0.18	0.002	0.002	0.004	0.004	0.003	0.003	0.001u	0.001u
38026	Flathead Sole	0.033	0.033	0.001u	0.001u	0.001	0.001	0.001u	0.001u	0.001u	0.001u
36050	English Sole	0.054		0.005		0.005		0.006		0.001u	
38021	English Sole	0.16		0.002		0.004		0.002		0.001u	
38023	English Sole	0.23	0.19	0.002	0.004	0.006	0.005	0.013	0.008	0.001u	0.001u
38024	English Sole	0.15		0.004		0.005		0.002		0.001u	
38025	English Sole	0.36		0.005		0.006		0.016		0.001u	
46053	Walleye Pollock	0.53		0.004		0.007		0.001		0.001u	
46054	Walleye Pollock	0.017		0.002		0.003		0.001u		0.001u	
46055	Walleye Pollock	0.20	0.17	0.026	<0.008	0.015	0.006	0.001	< 0.001	0.001u	0.001u
46056	Walleye Pollock	0.036		0.001u		0.002		0.001u		0.001u	
46057	Walleye Pollock	0.066		0.009		0.005		0.001u		0.001u	
46060	Pacific Hake	0.020		0.002		0.001		0.001u		0.001u	
46061	Pacific Hake	0.073		0.003		0.003		0.002		0.001u	
46062	Pacific Hake	0.038	0.044	0.002	0.002	0.001	0.002	0.001u	< 0.001	0.001u	0.001u
46063	Pacific Hake	0.036		0.002		0.002		0.001u		0.001u	
46059	Pacific Hake	0.053		0.003		0.002		0.001		0.001u	

* Concentrations Expressed in ug/g Wet Weight

Table A-2. cont.
PCB and Pesticide Concentrations* Found in Fish Muscle Tissue Sampled at the Old Town Dock

Lab. No.	Species	PCB 1254	Average	DDT	Average	DDE	Average	DDD	Average	HCB	Average
28001	Rockfish	0.059	0.059	0.002	0.002	0.007	0.007	0.001u	0.001u	0.001u	0.001u
28002	Pacific Staghorn Sculpin	0.10	0.10	0.001	0.001	0.008	0.008	0.001u	0.001u	0.001u	0.001u
29007	Buffalo Sculpin	0.032	0.032	0.001	0.001	0.002	0.002	0.001u	0.001u	0.001u	0.001u
29006	Rock Sole	0.096	0.11	0.001	0.002	0.006	0.006	0.001	<0.001	0.001u	0.001u
44006	Rock Sole	0.12		0.004		0.006		0.001u		0.001u	
29008	English Sole	0.16	0.12	0.002	0.001	0.002	0.003	0.001u	<0.001	0.001u	0.001u
29009	English Sole	0.091		0.001		0.003		0.001u		0.001u	
29040	English Sole	0.11		0.001		0.003		0.002		0.001u	
49075	Walleye Pollock	0.033		0.002		0.003		0.001u		0.001u	
49076	Walleye Pollock	0.031		0.002		0.003		0.001u		0.001u	
49077	Walleye Pollock	0.017	0.024	0.001u	< 0.002	0.002	0.003	0.001u	0.001u	0.001u	0.001u
49078	Walleye Pollock	0.019		0.001u		0.003		0.001u		0.001u	
49079	Walleye Pollock	0.019		0.002		0.002		0.001u		0.001u	
49080	Pacific Cod	0.050	0.050	0.004	0.004	0.002	0.002	0.001u	0.001u	0.001u	0.001u
49081	Pacific Hake	0.056		0.003		0.003		0.001		0.001u	
49082	Pacific Hake	0.050		0.001		0.002		0.001u		0.001u	
49083	Pacific Hake	0.14	0.093	0.006	0.004	0.008	0.004	0.004	<0.002	0.001u	0.001u
49084	Pacific Hake	0.12		0.004		0.002		0.001u		0.001u	
49085	Pacific Hake	0.10		0.004		0.004		0.003		0.001u	

* Concentrations Expressed in ug/g Wet Weight

Table A-2. cont.
PCB and Pesticide Concentrations*Found in Fish Muscle Tissue Sampled at the Point Defiance Dock

Lab. No.	Species	PCB 1254	Average	DDT	Average	DDE	Average	DDD	Average	HCB	Average
28000	Rock Sole	0.19		0.006		0.049		0.001		0.001u	
29000	Rock Sole	0.060	0.12	0.001u	<0.004	0.003	0.026	0.001u	<0.001	0.001u	0.001u
29001	Rock Sole	-	-	-	-	-	-	-	-	-	-
29002	English Sole	0.10		0.001u		0.003		0.001u		0.001u	
29003	English Sole	0.64	0.33	0.001u	<0.002	0.005	0.004	0.001	<0.003	0.001u	0.001u
38027	English Sole	0.25		0.005		0.005		0.006		0.001u	
29004	C-O Sole	0.070	0.070	0.001u	0.001u	0.001	0.001	0.001u	0.001u	0.001u	0.001u
38028	Buffalo Sculpin	0.011	0.011	0.001u	0.001u	0.001u	0.001u	0.001u	0.001u	0.001u	0.001u
01000	Walleye Pollock	0.085		0.008		0.006		0.001		0.001u	
01001	Walleye Pollock	0.031		0.001u		0.001		0.001u		0.001u	
01002	Walleye Pollock	0.027	0.058	0.001u	<0.005	0.001	0.004	0.001u	≤ 0.001	0.001u	0.001u
01003	Walleye Pollock	0.017		0.001u		0.002		0.001u		0.001u	
01005	Walleye Pollock	0.13		0.015		0.011		0.001u		0.001u	
01004	Pacific Staghorh Sculpin	0.045		0.001u		0.004		0.001		0.001u	
01006	Pacific Staghorn Sculpin	0.050	0.049	0.001	<0.002	0.011	0.007	0.001u	≤ 0.002	0.001u	0.001u
01007	Pacific Staghorn Sculpin	0.052		0.005		0.006		0.003		0.001u	

* Concentration Expressed in ug/g Wet Weight

Table A-2.cont.
PCB and Pesticide Concentrations* Found in Fish Muscle Tissue Sampled at Discovery Bay

Lab. No.	Species	PCB 1254	Average	DDT	Average	DDE	Average	DDD	Average	HCB	Average
40000	Starry Flounder	0.012	0.012	0.001u	0.001u	0.005	0.005	0.001u	0.001u	0.001u	0.001u
48005	Flathead Sole	0.010u	0.010u	0.001u	0.001u	0.001	0.001	0.001u	0.001u	0.001u	0.001u
48014	Pacific Staghorn Sculpin	0.010u		0.001u		0.002		0.001u		0.001u	
48015	Pacific Staghorn Sculpin	0.010u		0.001u		0.002		0.001u		0.001u	
48016	Pacific Staghorn Sculpin	0.010u	0.010u	0.001u	0.001u	0.002	0.002	0.001u	0.001u	0.001u	0.001u
48017	Pacific Staghorn Sculpin	0.010u		0.001u		0.004		0.001u		0.001u	
48018	Pacific Staghorn Sculpin	0.010u		0.001u		0.002		0.001u		0.001u	
48019	Pacific Tomcod	0.010u	0.010u	0.001u	0.001u	0.002	0.002	0.001u	0.001u	0.001u	0.001u
48000	English Sole	0.010u		0.001u		0.003		0.001u		0.001u	
48001	English Sole	0.017		0.002		0.002		0.001u		0.001u	
48002	English Sole	0.017	< 0.013	0.001u	< 0.001	0.003	0.003	0.001u	0.001u	0.001u	0.001u
48003	English Sole	0.010u		0.001u		0.003		0.001u		0.001u	
48004	English Sole	0.010u		0.001u		0.002		0.001u		0.001u	
48007	Walleye Pollock	0.010u		0.001u		0.001		0.001u		0.001u	
48008	Walleye Pollock	0.058		0.005		0.006		0.002		0.001u	
48010	Walleye Pollock	0.27	≤ 0.072	0.024	< 0.006	0.035	0.009	0.001u	≤ 0.001	0.001u	0.001u
48012	Walleye Pollock	0.010u		0.001u		0.002		0.001u		0.001u	
48013	Walleye Pollock	0.010u		0.001u		0.002		0.001u		0.001u	

* Concentrations Expressed in μg/g Wet Weight

Table A-3.

PCB and Pesticide Concentrations*Found in Crab Muscle Tissue Sampled at the Hylebos Waterway, City Waterway and Discovery Bay

Lab. No.	Species	PCB 1254	Average	DDT	Average	DDE	Average	DDD	Average	HCB	Average
36058	Dungeness Crab	0.058	0.052	0.001u	<0.001	0.003	0.002	0.001	<0.001	0.019	0.018
36059	Dungeness Crab	0.047		0.001		0.002		0.001u		0.018	
Station:	City Waterway										
Lab. No.	Species	PCB 1254	Average	DDT	Average	DDE	Average	DDD	Average	HCB	Average
36056	Dungeness Crab	0.083	0.068	0.002	0.002	0.005	0.004	0.001u	<0.001	0.001u	0.001u
36057	Dungeness Crab	0.053		0.001		0.004		0.001		0.001u	
Station:	Discovery Bay										
Lab. No.	Species	PCB 1254	Average	DDT	Average	DDE	Average	DDD	Average	HCB	Average
48006	Dungeness Crab	0.010u	0.010u	0.001u	0.001u	0.006	0.005	0.001u	0.001u	0.001u	0.001u
48011	Dungeness Crab	0.010u		0.001u		0.004		0.001u		0.001u	

* Concentration Expressed in ug/g Wet Weight

APPENDIX B.

Comparison of Concentration of Metals Among Fish Species and Sampling Sites

NOTE: "u" denotes concentration is less than detection limit

" $\leq$ " denotes quantifiable concentrations have been averaged together with "u" concentrations

For more information concerning detection limits see Appendix F page 115.

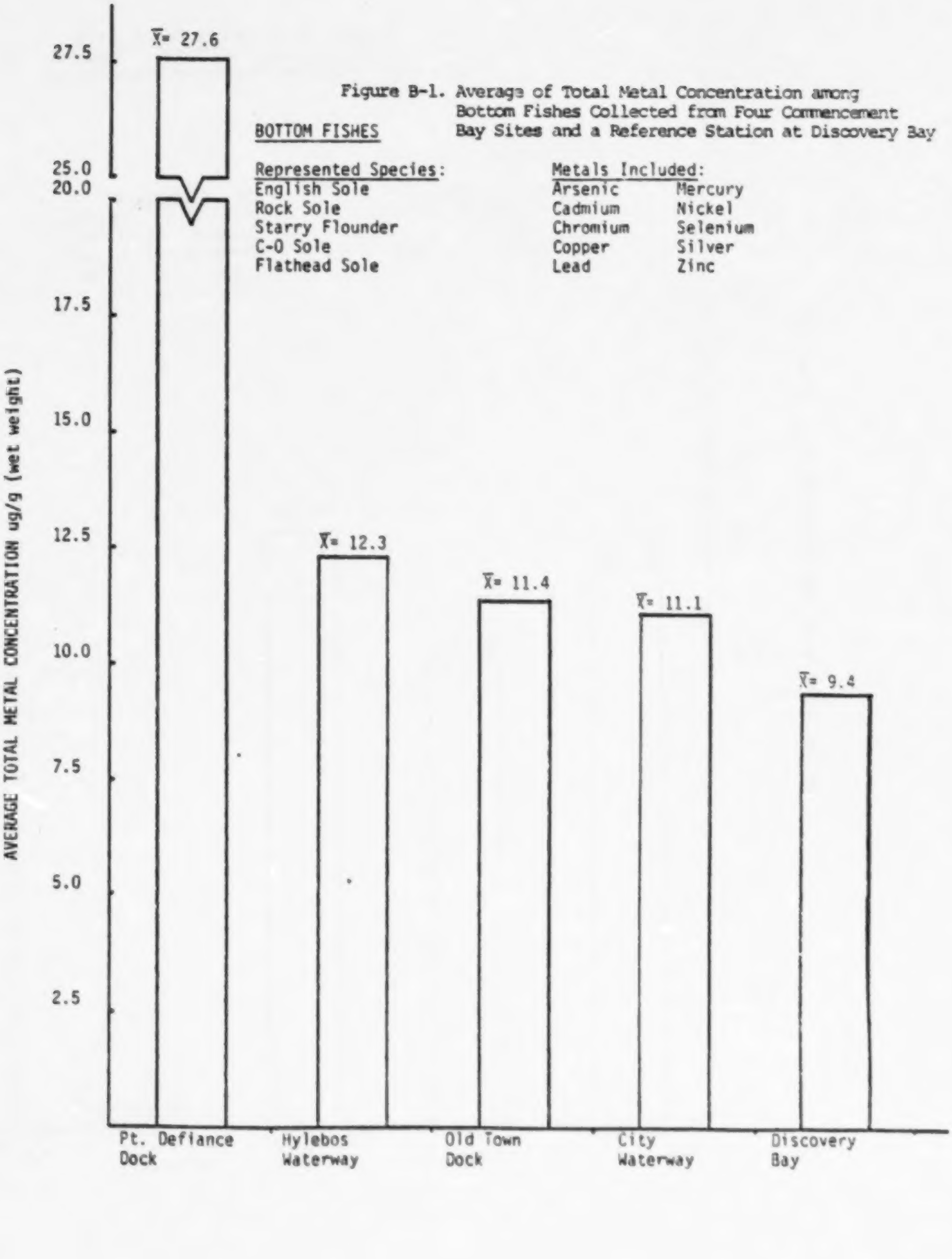
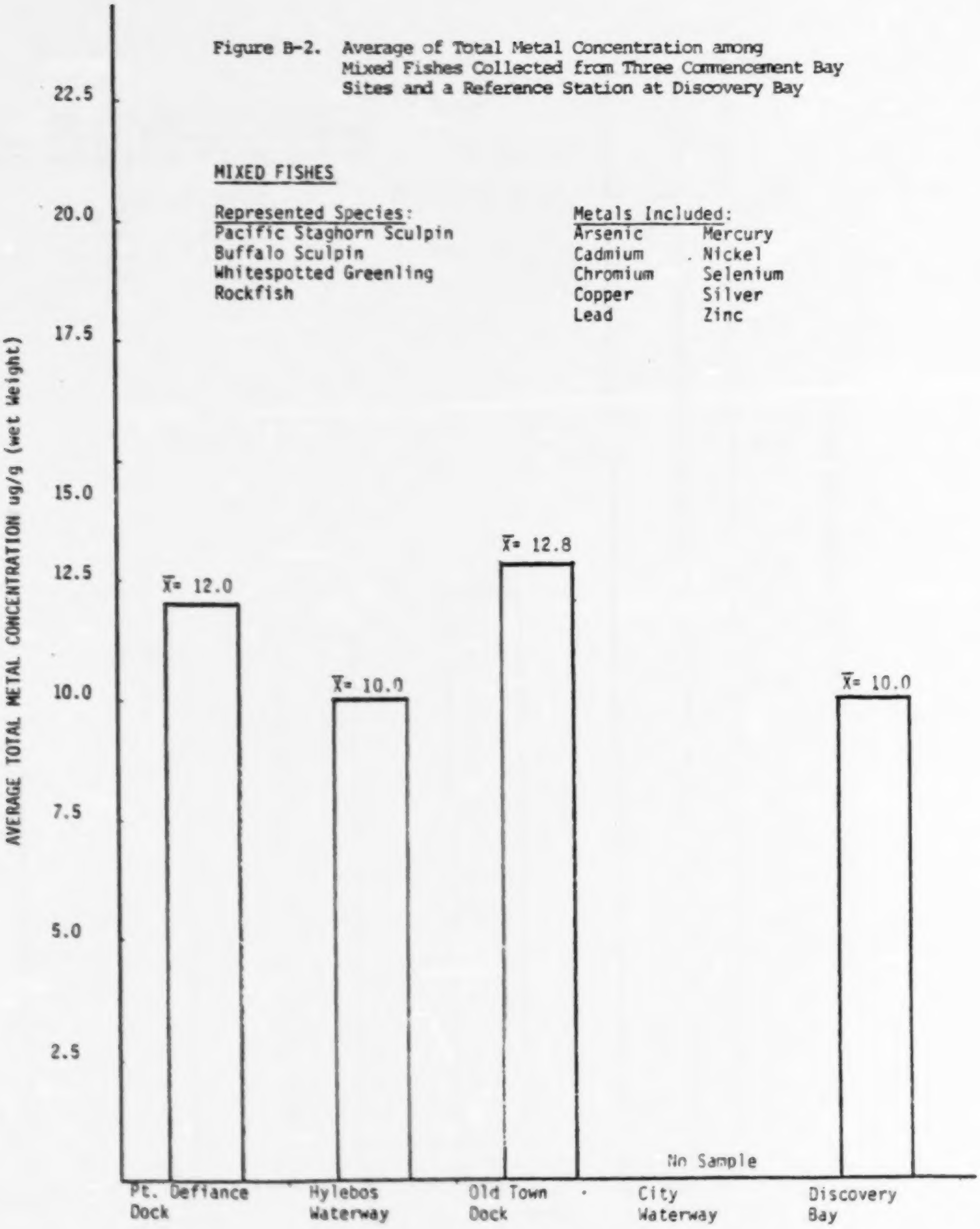


Figure B-1. Average of Total Metal Concentration among Bottom Fishes Collected from Four Commencement Bay Sites and a Reference Station at Discovery Bay

Figure B-2. Average of Total Metal Concentration among Mixed Fishes Collected from Three Commencement Bay Sites and a Reference Station at Discovery Bay



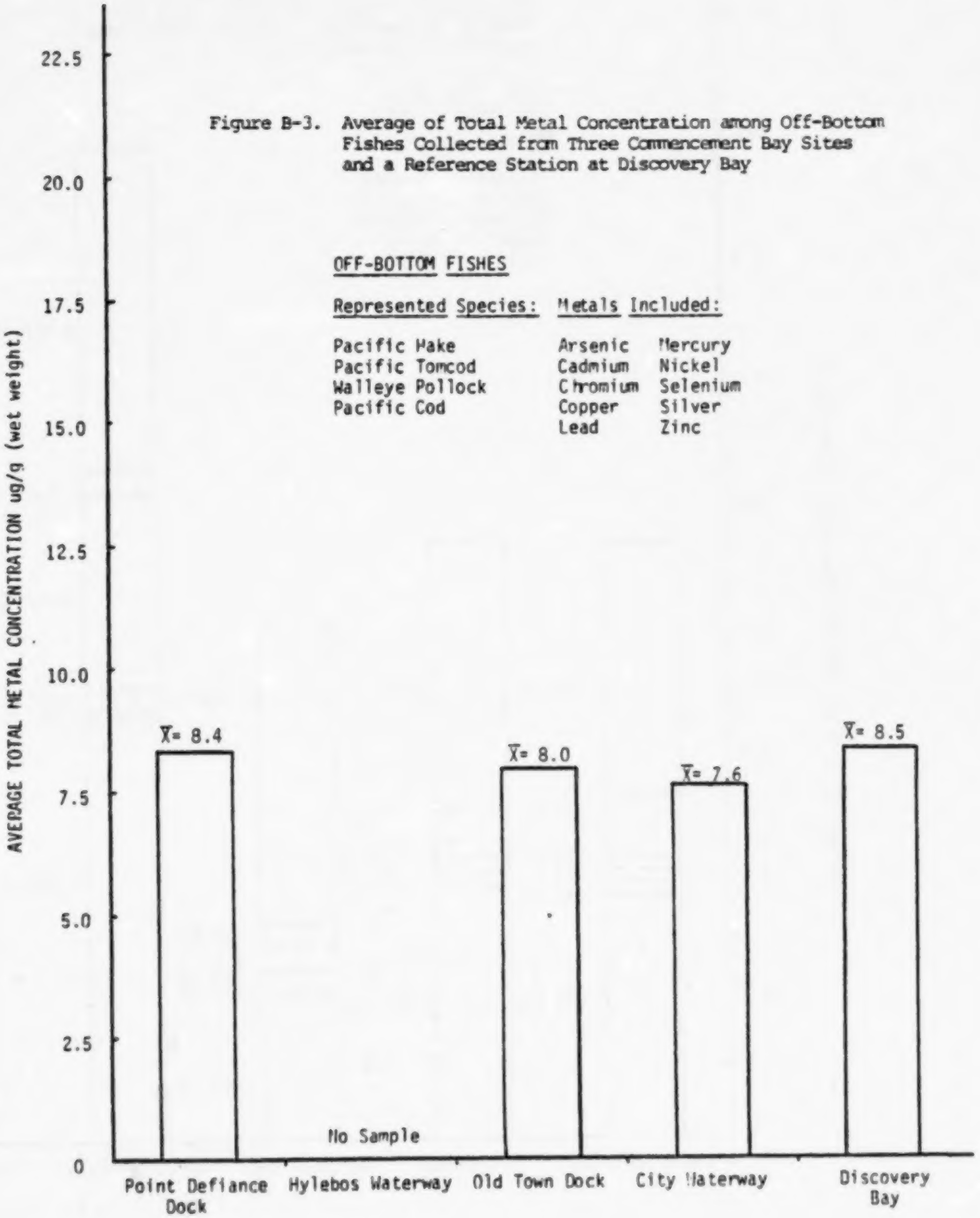


Figure B-3. Average of Total Metal Concentration among Off-Bottom Fishes Collected from Three Commencement Bay Sites and a Reference Station at Discovery Bay

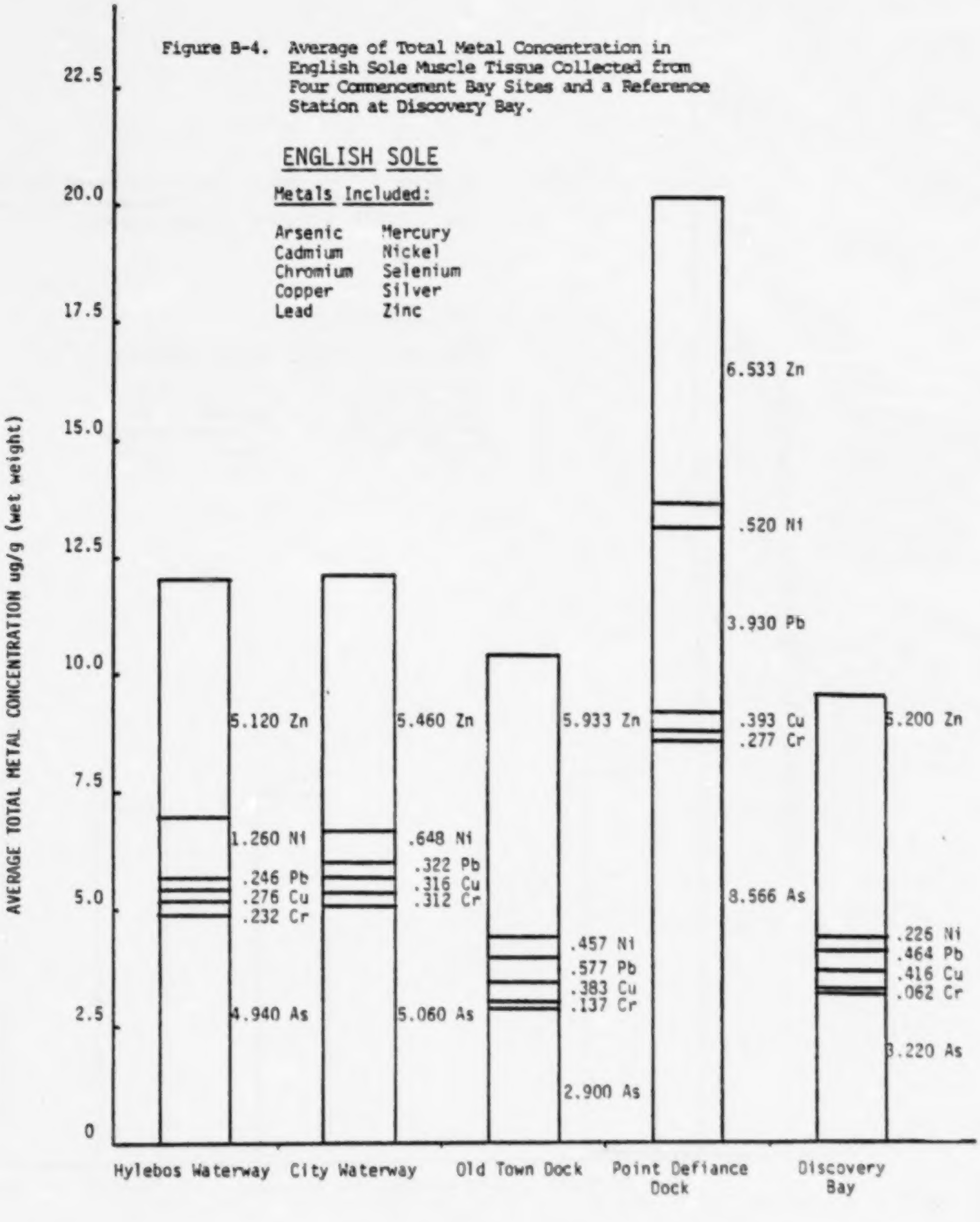


Figure B-4. Average of Total Metal Concentration in English Sole Muscle Tissue Collected from Four Commencement Bay Sites and a Reference Station at Discovery Bay.

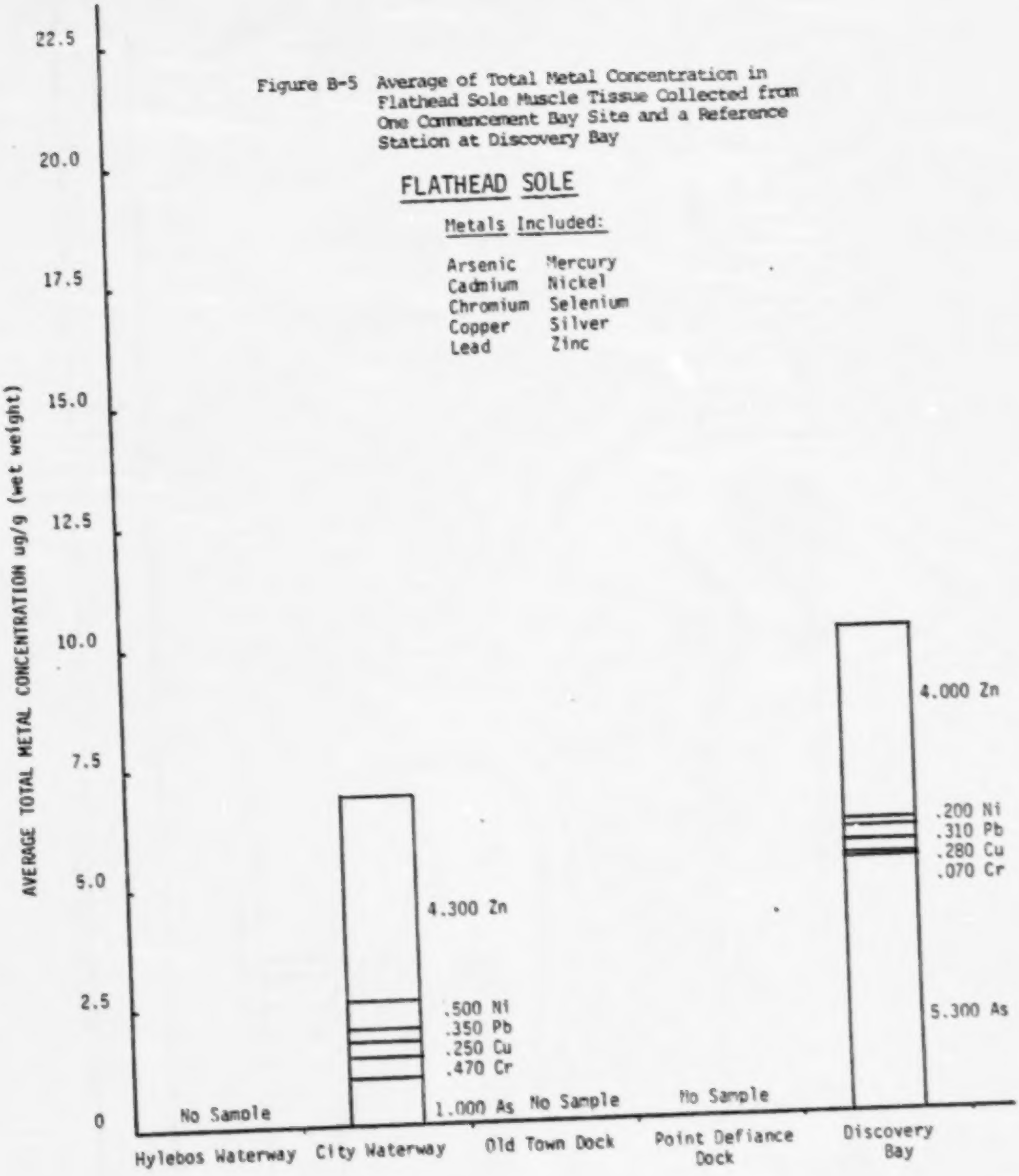


Figure B-5 Average of Total Metal Concentration in Flathead Sole Muscle Tissue Collected from One Commencement Bay Site and a Reference Station at Discovery Bay

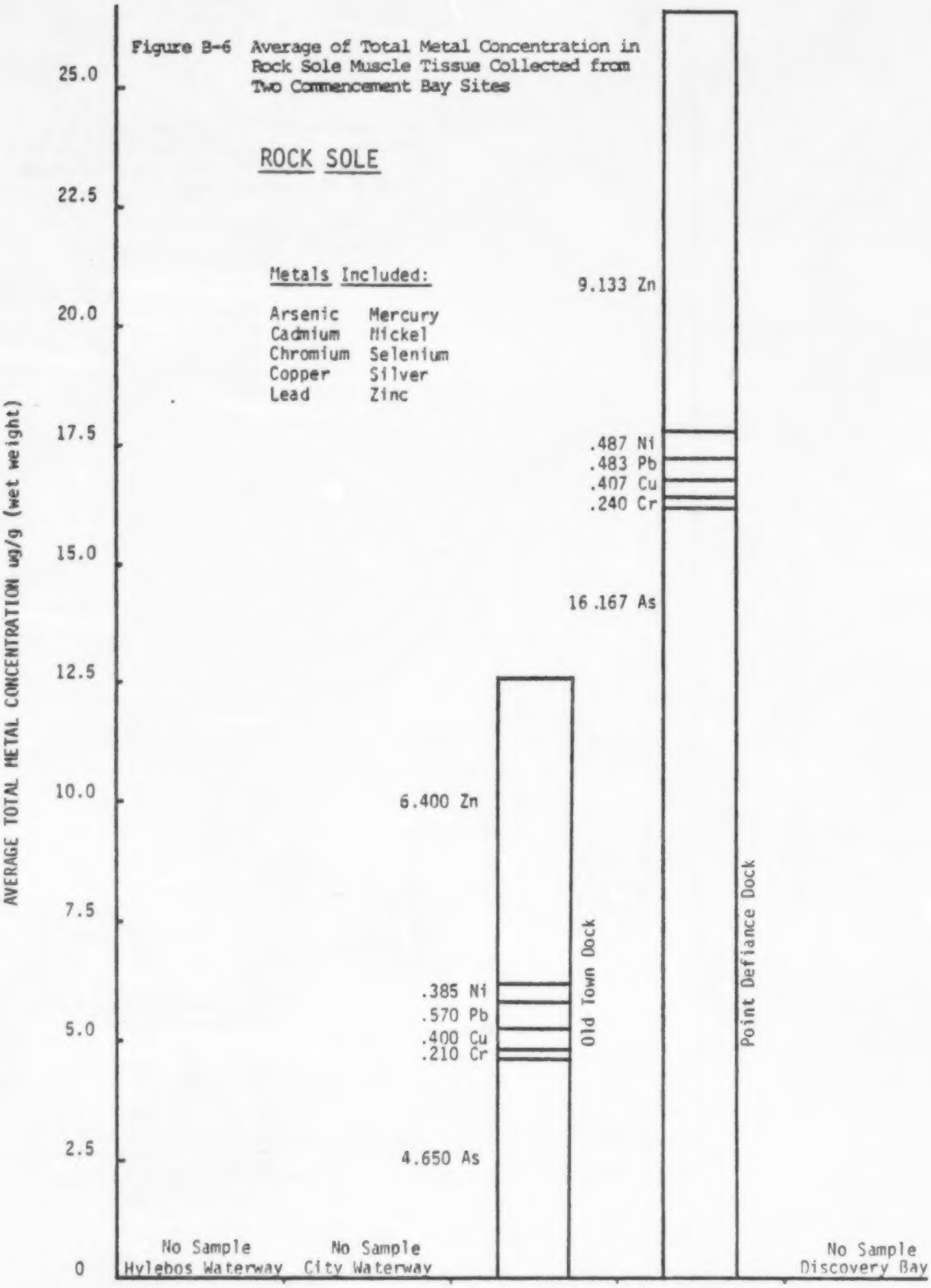


Figure B-6 Average of Total Metal Concentration in Rock Sole Muscle Tissue Collected from Two Commencement Bay Sites

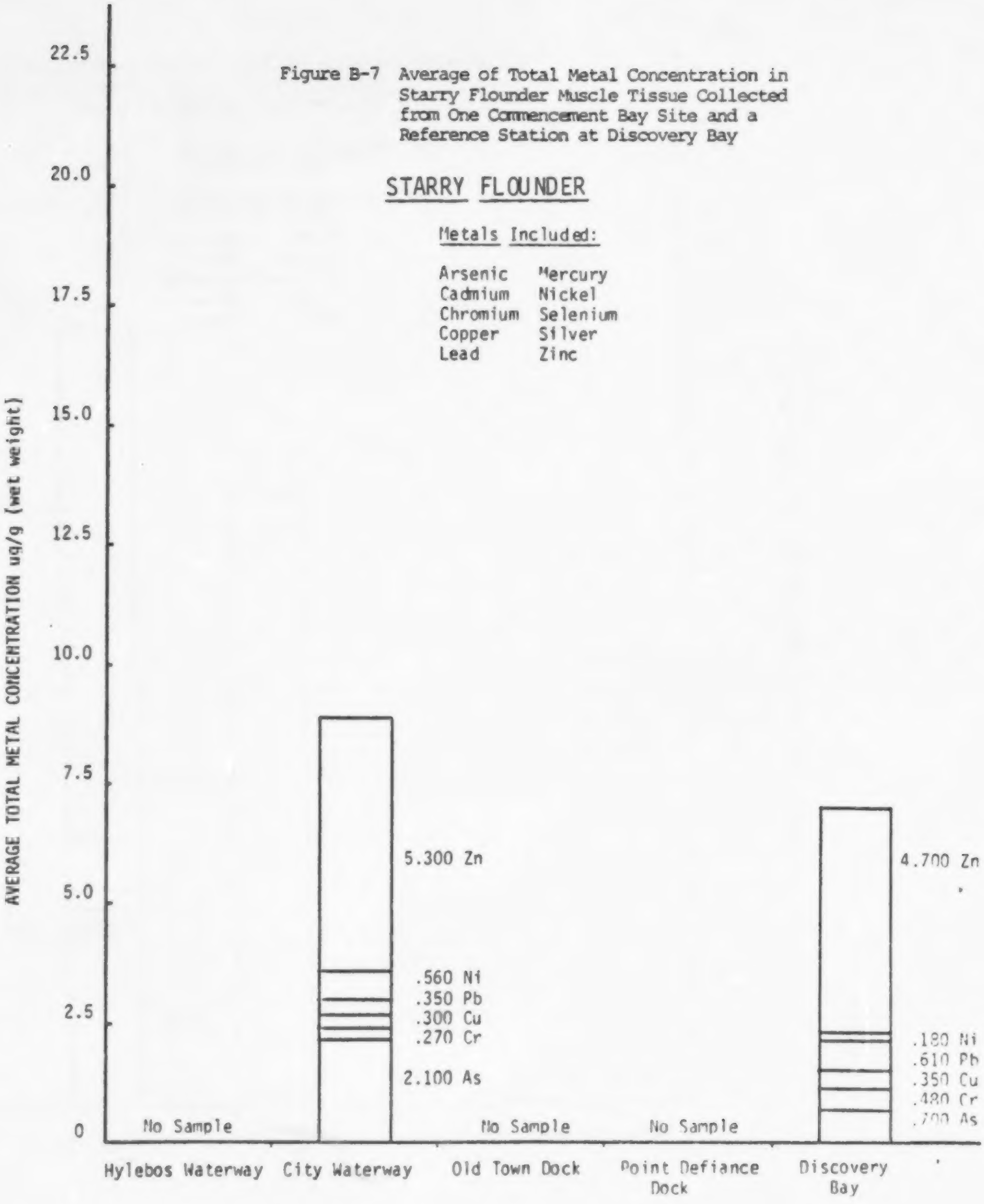


Figure B-7 Average of Total Metal Concentration in Starry Flounder Muscle Tissue Collected from One Commencement Bay Site and a Reference Station at Discovery Bay

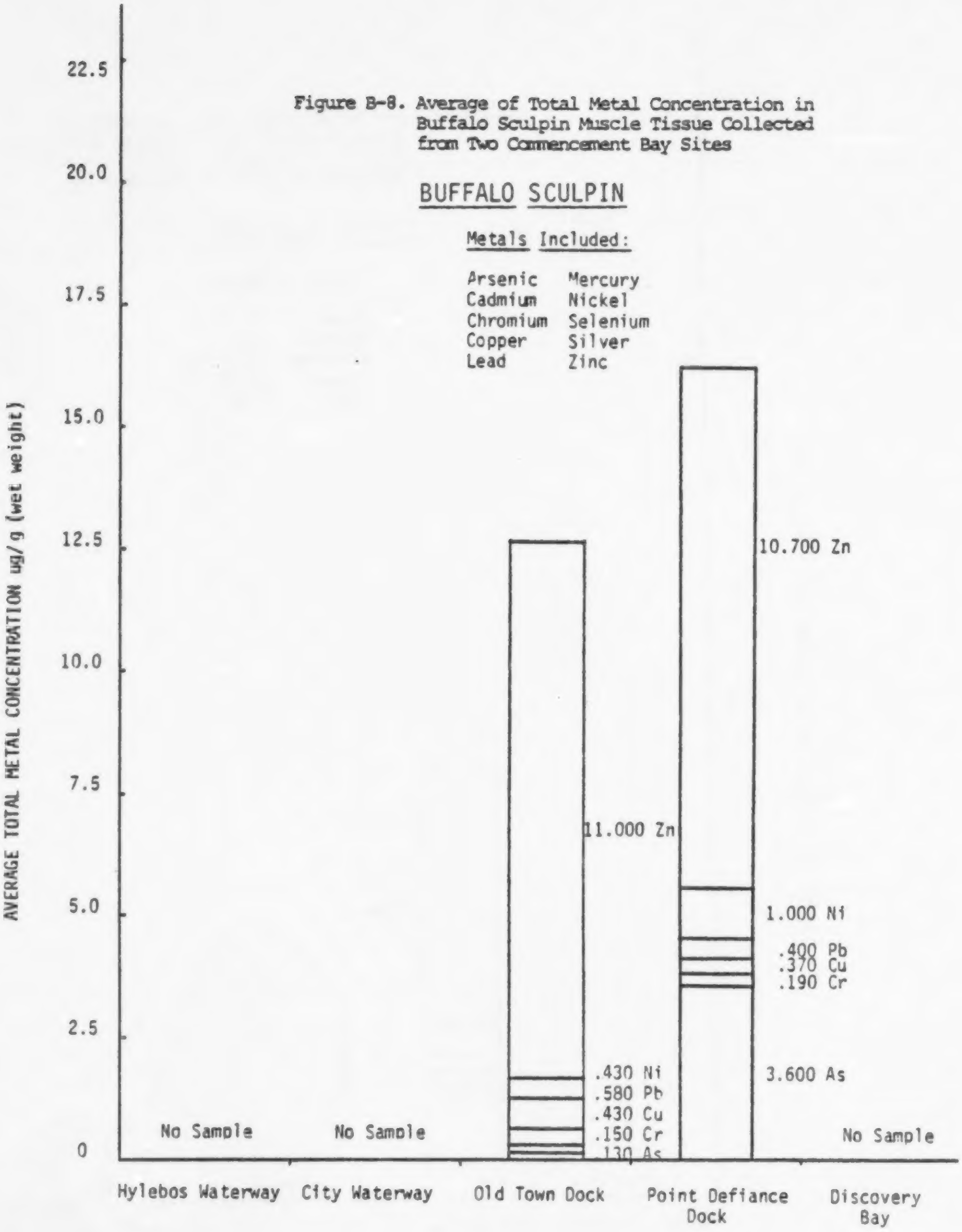


Figure B-8. Average of Total Metal Concentration in Buffalo Sculpin Muscle Tissue Collected from Two Commencement Bay Sites

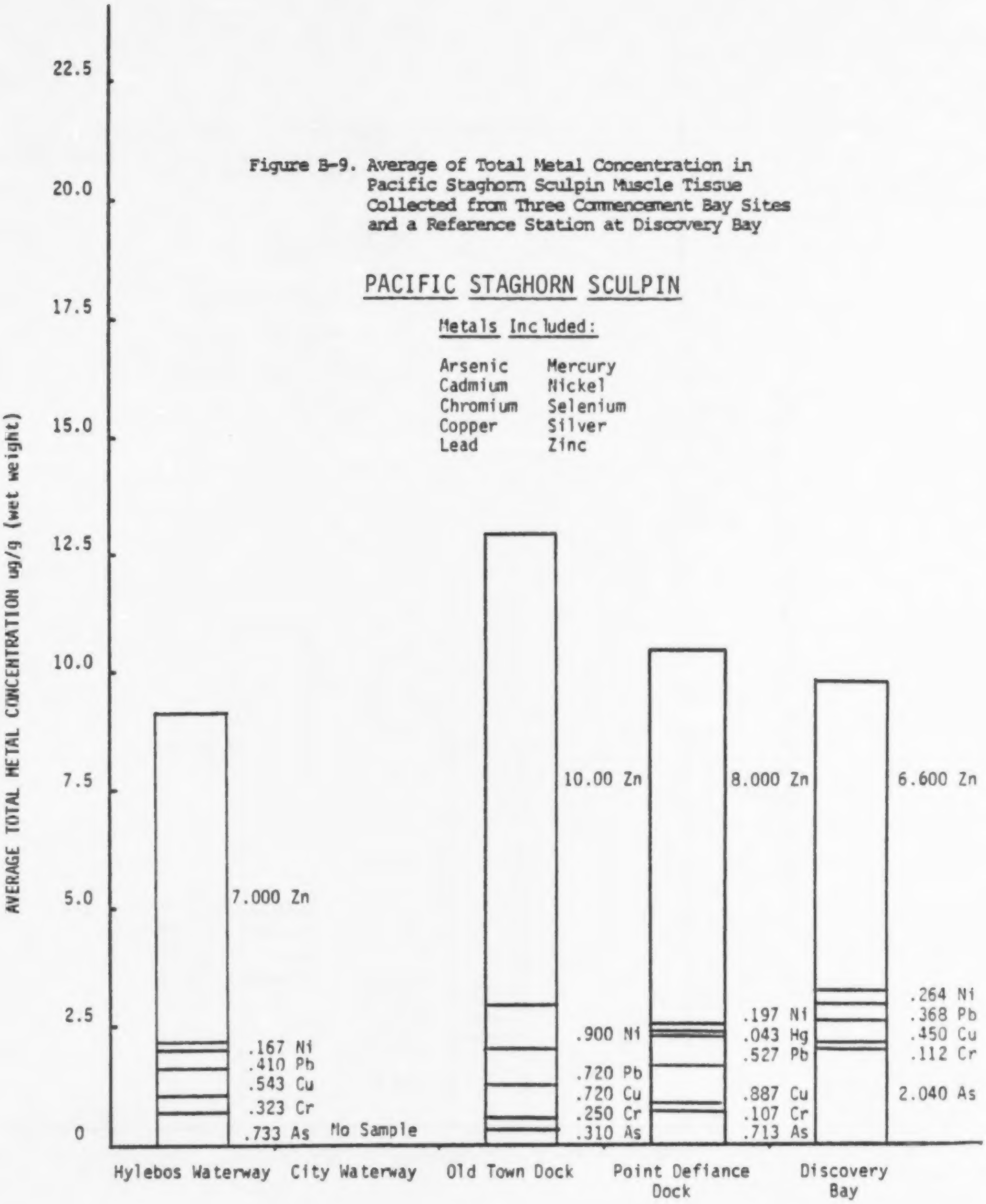


Figure B-9. Average of Total Metal Concentration in Pacific Staghorn Sculpin Muscle Tissue Collected from Three Commencement Bay Sites and a Reference Station at Discovery Bay

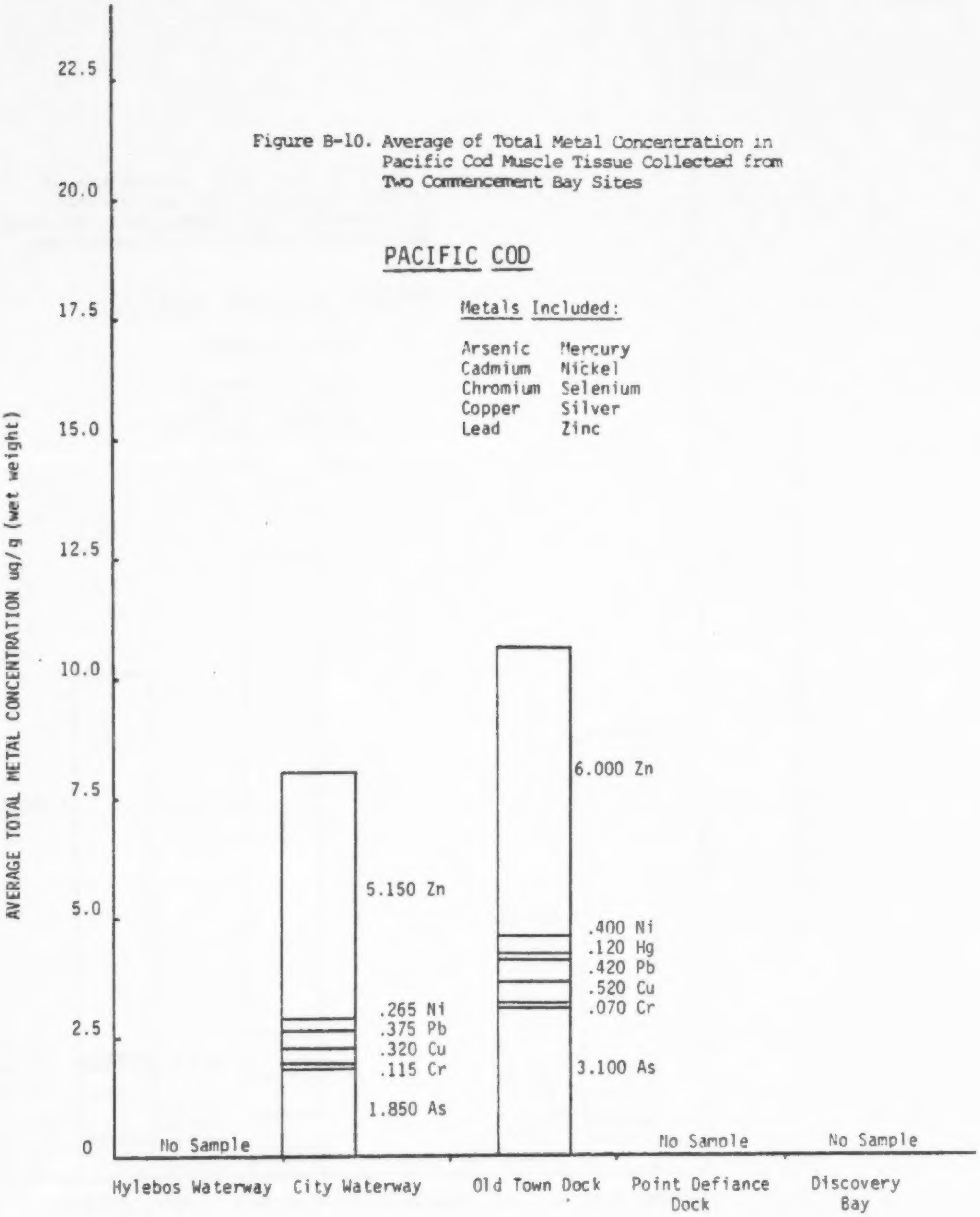


Figure B-10. Average of Total Metal Concentration in Pacific Cod Muscle Tissue Collected from Two Commencement Bay Sites

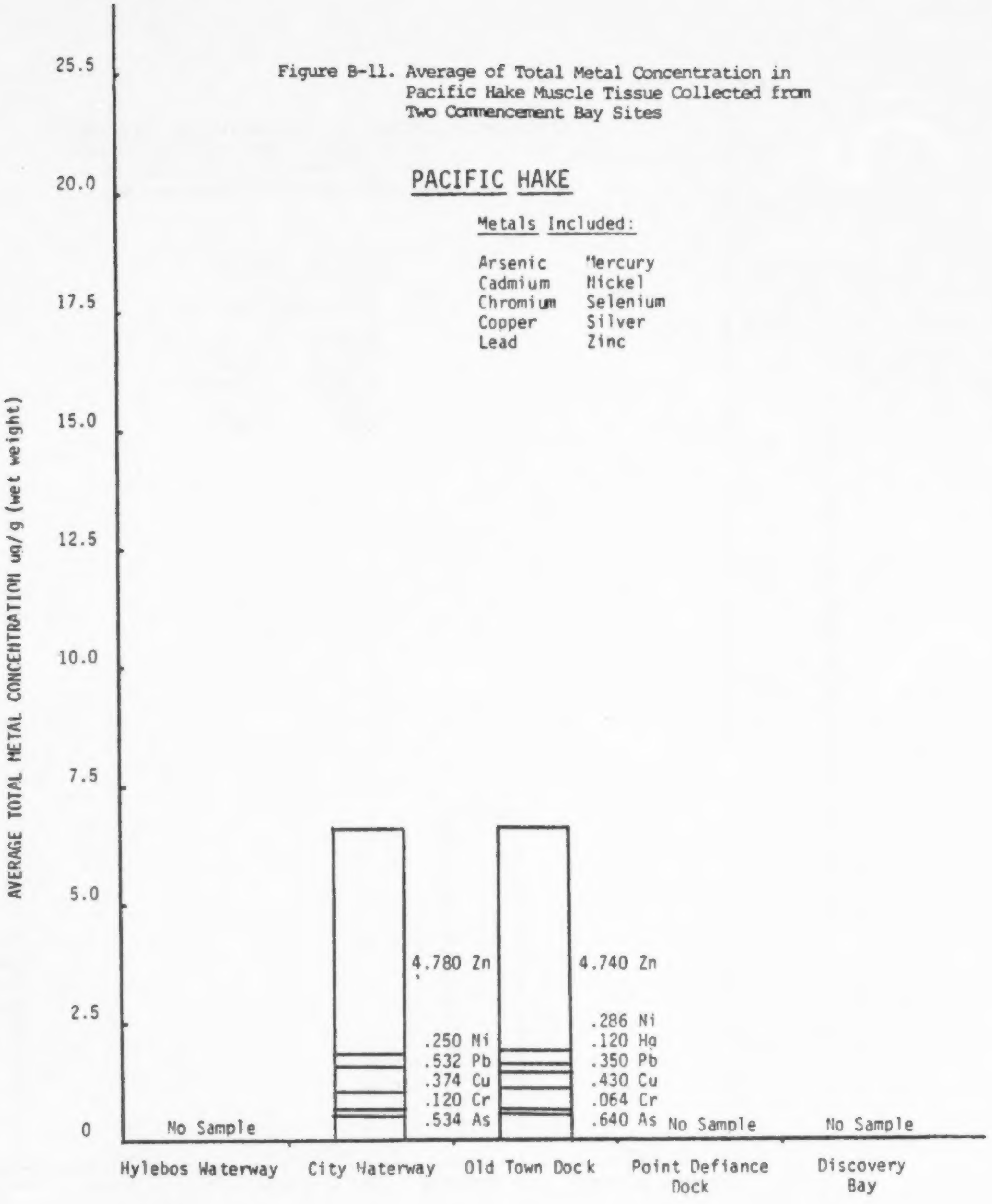


Figure B-11. Average of Total Metal Concentration in Pacific Hake Muscle Tissue Collected from Two Commencement Bay Sites

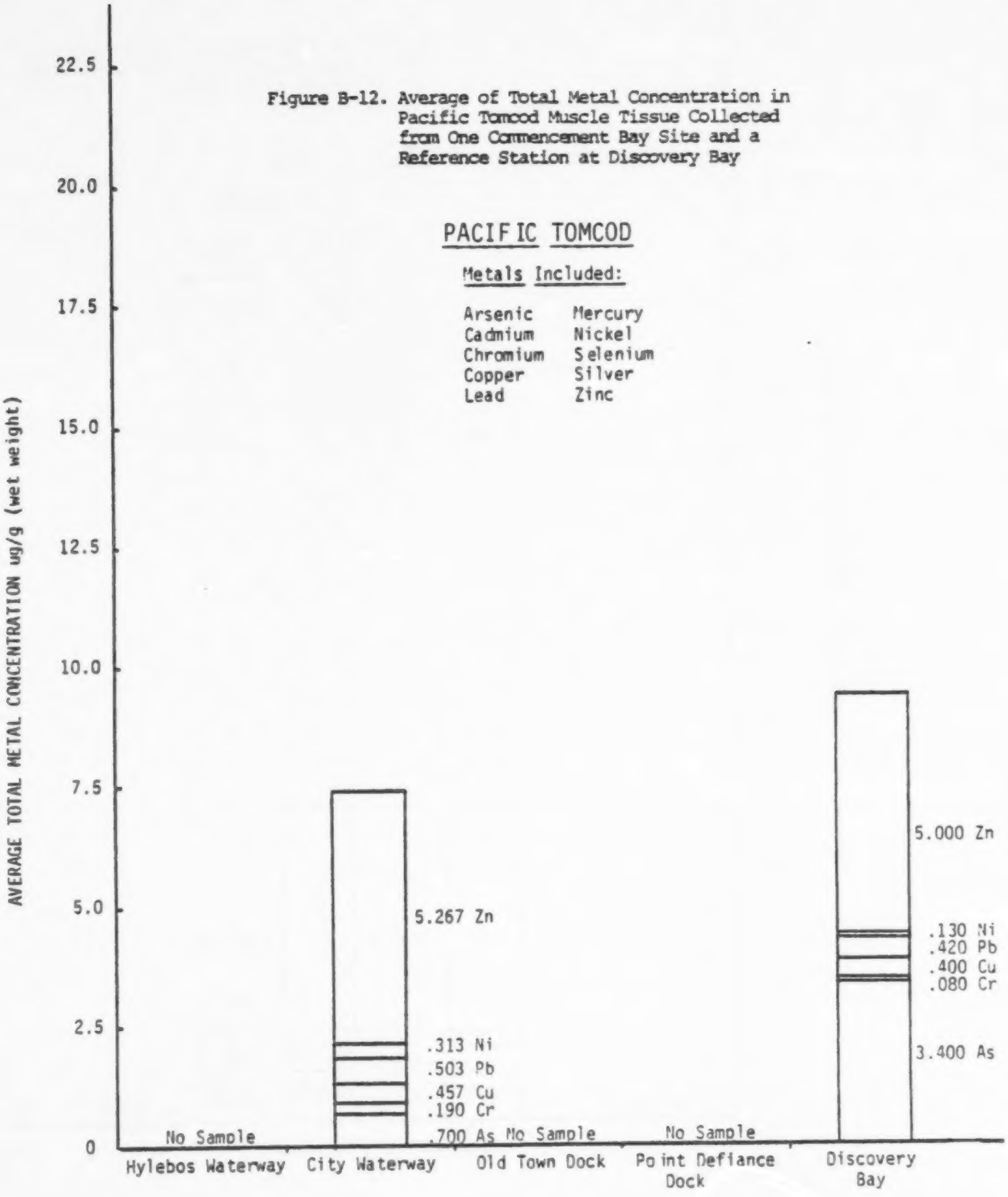


Figure B-12. Average of Total Metal Concentration in Pacific Tomcod Muscle Tissue Collected from One Commencement Bay Site and a Reference Station at Discovery Bay

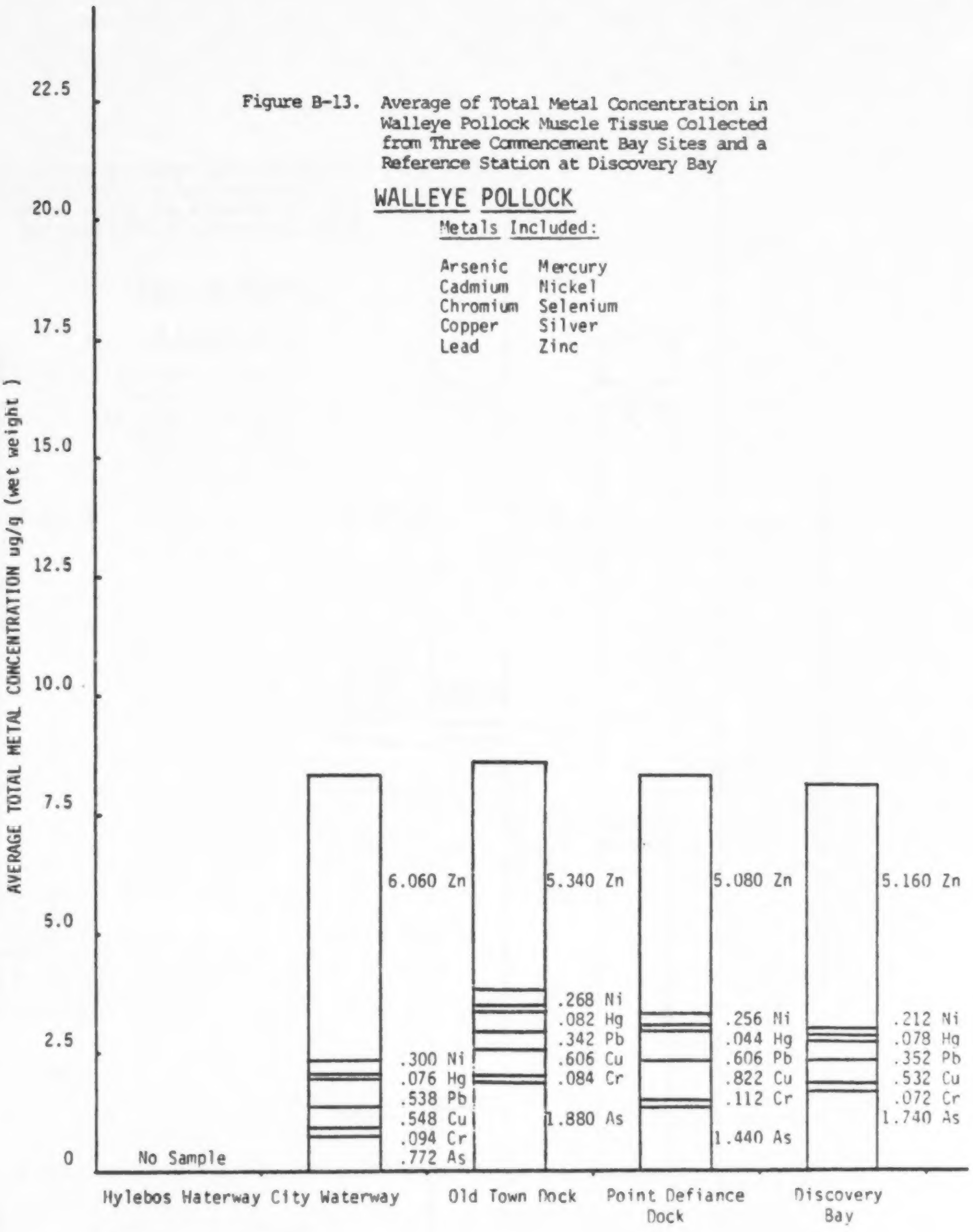


Figure B-13. Average of Total Metal Concentration in Walleye Pollock Muscle Tissue Collected from Three Commencement Bay Sites and a Reference Station at Discovery Bay

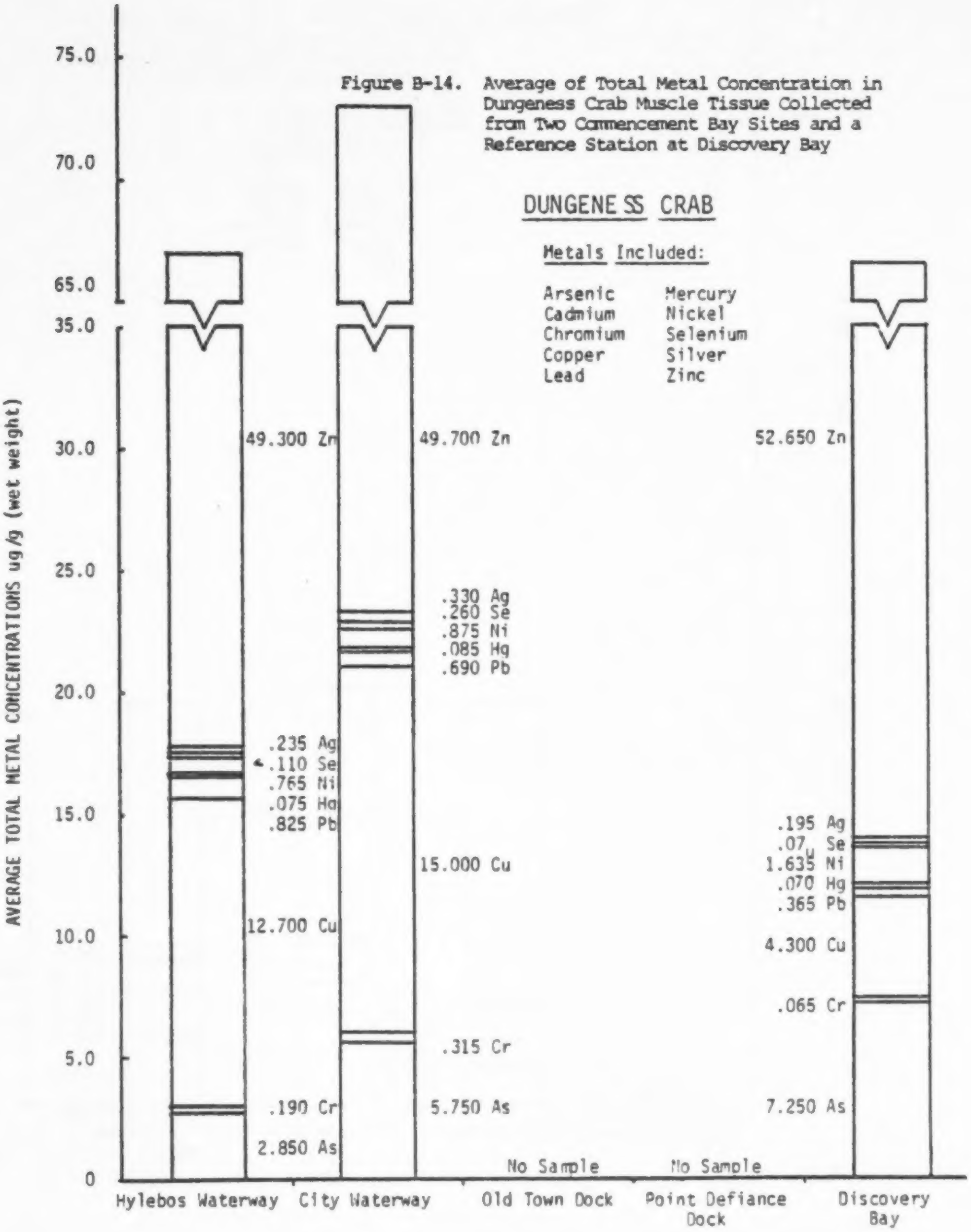


Figure B-14. Average of Total Metal Concentration in Dungeness Crab Muscle Tissue Collected from Two Commencement Bay Sites and a Reference Station at Discovery Bay

Table B-1.

Average Metal Concentrations Found in Fish Species Sampled in the Commencement Bay Area and a Reference Station at Discovery Bay ug/g wet weight

C-O SOLE	(N)	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
Hylebos Waterway											
City Waterway											
Old Town Dock											
Point Defiance Dock	(1)	37.8	0.006	0.18	0.44	0.65	0.02	0.50	0.06	0.006u	10.7
Discovery Bay											
ENGLISH SOLE	(N)										
Hylebos Waterway	(5)	4.9	0.008	0.23	0.28	0.25	0.03	1.3	< 0.14	0.07u	5.1
City Waterway	(5)	5.1	0.005u	0.31	0.32	0.32	0.04	0.65	0.07u	0.01u	5.5
Old Town Dock	(3)	2.9	0.007	0.14	0.38	0.58	0.03	0.46	0.12	0.006u	5.9
Point Defiance Dock	(3)	8.6	0.007	0.28	0.39	3.9	0.03	0.52	< 0.13	0.006u	6.5
Discovery Bay	(5)	3.2	< 0.006	0.06	0.42	0.46	0.04	0.23	0.07u	0.01u	5.2
FLATHEAD SOLE	(N)										
Hylebos Waterway											
City Waterway	(1)	1.0	0.005u	0.47	0.25	0.35	0.04	0.50	0.30u	0.007u	4.3
Old Town Dock											
Point Defiance Dock											
Discovery Bay	(1)	5.3	0.004u	0.07	0.28	0.31	0.04	0.20	0.07u	0.01u	4.0

Table B-1. cont.

Average Metal Concentrations Found in Fish Species Sampled in the Commencement Bay Area and a Reference Station at Discovery Bay, ug/g wet weight

ROCK SOLE	(N)	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
Hylebos Waterway											
City Waterway											
Old Town Dock	(2)	4.6	0.008	0.21	0.40	0.57	0.02	0.38	0.07u	0.008u	6.4
Point Defiance Dock	(3)	16.2	0.007	0.24	0.41	0.48	0.05	0.49	0.24	0.006u	9.1
Discovery Bay											
STARRY FLOUNDER	(N)										
Hylebos Waterway											
City Waterway	(1)	2.1	0.005u	0.27	0.30	0.35	0.04	0.56	0.30u	0.007u	5.3
Old Town Dock											
Point Defiance Dock											
Discovery Bay	(1)	0.70	0.013	0.48	0.35	0.61	0.05	0.18	0.17	0.007u	4.7
BUFFALO SCULPIN	(N)										
Hylebos Waterway											
City Waterway											
Old Town Dock	(1)	0.13	0.004	0.15	0.43	0.58	0.02	0.43	0.06u	0.009	11.0
Point Defiance Dock	(1)	3.6	0.005u	0.19	0.37	0.40	0.02	1.0	0.06u	0.007u	10.7
Discovery Bay											

Table B-1. cont.

Average Metal Concentrations Found in Fish Species Sampled in the Commencement Bay Area and a Reference Station at Discovery Bay ug/g wet weight

PACIFIC STAGHORN SCULPIN (N)	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
Hylebos Waterway (3)	0.73	0.021	0.32	0.54	0.41	0.02	0.17	0.08u	0.010u	7.0
City Waterway										
Old Town Dock (1)	0.31	0.012	0.25	0.72	0.72	0.03	0.90	0.12	0.006u	10.0
Point Defiance Dock (3)	0.71	0.004u	0.11	0.89	0.53	0.04	0.20	0.07u	0.007u	8.0
Discovery Bay (5)	2.0	< 0.004	0.11	0.45	0.37	0.03	0.26	0.07u	0.010u	6.6
ROCKFISH (N)										
Hylebos Waterway										
City Waterway										
Old Town Dock (1)	0.55	0.012	0.28	0.66	0.58	0.03	0.48	0.14	0.006u	9.8
Point Defiance Dock										
Discovery Bay										
WHITESPOTTED GREENLING (N)										
Hylebos Waterway (3)	0.71	0.010	0.49	0.42	0.31	0.17	0.18	0.08u	0.010u	8.3
City Waterway										
Old Town Dock										
Point Defiance Dock										
Discovery Bay										

Table B-1. cont.

Average Metal Concentrations Found in Fish Species Sampled in the Commencement Bay Area and a Reference Station at Discovery Bay ug/g wet weight

PACIFIC COD (N)	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
Hylebos Waterway										
City Waterway (2)	1.8	0.014	0.12	0.32	0.38	0.04	0.26	0.07u	0.010u	5.2
Old Town Dock (1)	3.1	0.004	0.07	0.52	0.42	0.12	0.40	0.07u	0.010u	6.0
Point Defiance Dock										
Discovery Bay										
PACIFIC HAKE (N)										
Hylebos Waterway										
City Waterway (5)	0.53	0.012	0.12	0.37	0.53	0.07	0.25	0.07u	0.010u	4.8
Old Town Dock (5)	0.64	0.006	0.06	0.43	0.35	0.10	0.29	0.07u	0.010u	4.7
Point Defiance Dock										
Discovery Bay										
PACIFIC TOMCOD (N)										
Hylebos Waterway										
City Waterway (3)	0.70	0.013	0.19	0.46	0.50	0.03	0.31	< 0.07	0.009u	5.3
Old Town Dock										
Point Defiance Dock										
Discovery Bay (1)	3.4	0.006	0.08	0.40	0.42	0.04	0.13	0.07u	0.010u	5.0

Table B-1. cont.

Average Metal Concentrations Found in Fish and Crab Species Sampled in the Commencement Bay Area and a Reference Station at Discovery Bay ug/g wet weight

WALLEYE POLLOCK (N)	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
Hylebos Waterway										
City Waterway (5)	0.77	0.015	0.09	0.55	0.54	0.08	0.30	0.07u	0.010u	6.1
Old Town Dock (5)	1.9	0.006	0.08	0.61	0.34	0.08	0.27	0.07u	0.010u	5.3
Point Defiance Dock (5)	1.4	0.004u	0.11	0.82	0.61	0.04	0.26	0.07u	0.007u	5.1
Discovery Bay (5)	1.7	<0.005	0.07	0.53	0.35	0.08	0.21	0.07u	0.010u	5.2
DUNGENESS CRAB (N)										
Hylebos Waterway (2)	2.8	0.027	0.19	12.7	0.82	0.08	0.76	< 0.11	0.235	49.3
City Waterway (2)	5.8	0.032	0.32	15.0	0.69	0.08	0.88	0.26	0.330	49.7
Old Town Dock										
Point Defiance Dock										
Discovery Bay (2)	7.2	0.021	0.06	4.3	0.36	0.07	1.6	0.07u	0.195	52.6

Table B-2. Average Metal Concentrations Identified in Fish Muscle Tissue Sampled in the Commencement Bay Area and a Reference Station at Discovery Bay, ug/g wet weight

Station	Species	(N)	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
			Mean Range	Mean Range	Mean Range	Mean Range	Mean Range	Mean Range	Mean Range	Mean Range	Mean Range	Mean Range
Pt. Defiance Dock	C-O Sole	1	37.8 -	0.006 -	0.18 -	0.44 -	0.65 -	0.02 -	0.50 -	0.06 -	0.006u -	10.7 -
	Rock Sole	3	16.2 2.5-34.1	0.007 0.006-.008	0.24 0.20-0.28	0.41 0.35- 0.47	0.48 0.45.0.55	0.05 0.02-0.05	0.49 0.36-0.60	0.24 0.18-0.29	0.006u -	9.1 8.8-9.8
	English Sole	3	8.6 3.2-14.6	0.007 0.004-0.01	0.28 0.20-0.41	0.39 0.27-0.49	3.9 0.67-10.4	0.03 0.02-0.03	0.52 0.40-0.73	0.13 0.06u -0.17	0.006u .006u-.007u	6.5 5.3-7.3
	Buffalo Sculpin	1	3.6 -	0.005u -	0.19 -	0.37 -	0.40 -	0.02 -	0.10 -	0.06u -	0.007u -	10.7 -
	Pacific Staghorn Sculpin	3	0.71 0.60-0.87	0.004u -	0.11 0.08-0.12	0.89 0.66-1.2	0.53 0.42-0.67	0.04 0.03-0.07	0.20 0.12-0.25	0.07u -	0.007u -	8.0 7.0-8.7
	Walleye Pollock	5	1.4 0.40-2.2	0.004u -	0.11 0.08-0.14	0.82 0.71-0.85	0.61 0.53-0.63	0.04 0.02-0.08	0.26 0.19-0.40	0.07u -	0.007u -	5.1 4.7-6.0
Hylebos Waterway	English Sole	5	4.9 3.0-7.3	0.008 .006-.011	0.23 0.11-0.62	0.28 0.25-0.31	0.25 0.18-0.36	0.03 0.02-0.04	1.3 1.2-1.4	< 0.14 0.08u-0.38	0.07u -	5.1 4.8-5.6
	Whitespotted Greenling	3	0.71 0.44- 0.89	0.01 0.006-0.019	0.49 0.39-0.65	0.42 0.35- 0.47	0.31 0.28-0.37	0.17 0.07-0.23	0.18 0.17-0.20	0.08u -	0.01u -	8.3 7.7-9.0
	Pacific Staghorn Sculpin	3	0.73 0.51-1.1	0.02 0.017-0.025	0.32 0.30-0.34	0.54 0.44- 0.65	0.41 0.22-0.70	0.02 0.01-0.04	0.17 0.1-0.23	0.08u -	0.01u -	7.0 6.3-7.7

Table B-2 cont. Average Metal Concentrations Identified in Fish Muscle Tissue Sampled in the Commencement Bay Area and a Reference Station at Discovery Bay, ug/g wet weight

Station	Species	(N)	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury		Nickel		Selenium		Silver		Zinc	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Old Town Dock	Pacific Staghorn Sculpin	1	0.31	-	0.012	-	0.25	-	0.72	-	0.72	-	0.03	-	0.90	-	0.12	-	0.006u	-	10.0	-
	Buffalo Sculpin	1	0.13	-	0.004	-	0.15	-	0.43	-	0.58	-	0.02	-	0.43	-	0.06u	-	0.009	-	11.0	-
	Rock Sole	2	4.6	1.5- 7.8	0.008	0.006-0.009	0.21	0.14-0.28	0.40	0.39- 0.41	0.57	0.33- 0.81	0.02	0.01- 0.03	0.38	0.27-0.50	0.07u	0.06u-0.08u	0.008u	0.006u-0.01u	6.4	6.0-6.8
	Rockfish	1	0.55	-	0.012	-	0.28	-	0.66	-	0.58	-	0.03	-	0.48	-	0.14	-	0.006u	-	9.8	-
	Pacific Cod	1	3.1	-	0.004	-	0.07	-	0.52	-	0.42	-	0.12	-	0.40	-	0.07u	-	0.01u	-	6.0	-
	English Sole	3	2.9	2.1-3.4	0.007	0.006-0.008	0.14	0.13-0.15	0.38	0.35-0.40	0.58	0.49-0.69	0.03	0.02-0.04	0.46	0.44-0.48	0.12	0.09-0.15	0.006u	-	5.9	5.5-6.3
	Walleye Pollock	5	1.9	1.1-3.4	0.006	0.004-0.006	0.08	0.07- 0.12	0.61	0.41-0.81	0.34	0.31-0.42	0.08	0.04-0.12	0.27	0.17-0.37	0.07u	-	0.01u	-	5.3	4.7-6.0
	Pacific Hake	5	0.64	0.50-0.90	0.006	0.004-0.016	0.06	0.05- 0.08	0.43	0.33-0.67	0.35	0.31-0.39	0.01	0.07-0.13	0.29	0.17-0.40	0.07u	-	0.01u	-	4.7	4.0-5.7
City Waterway	English Sole	5	5.1	2.8-8.6	0.005u	-	0.31	0.20-0.64	0.32	0.26-0.50	0.32	0.20-0.45	0.04	0.01-0.09	0.65	0.48-1.2	0.07u	-	0.01u	-	5.5	4.3-7.7
	Starry Flounder	1	2.1	-	0.005u	-	0.27	-	0.30	-	0.35	-	0.04	-	0.56	-	0.30u	-	0.007u	-	5.3	-
	Walleye Pollock	5	0.77	0.43-0.97	0.015	0.013-0.016	0.09	0.07-0.12	0.55	0.44-0.71	0.54	0.42-0.68	0.08	0.06-0.09	0.30	0.15-0.40	0.07u	-	0.01u	-	6.1	5.3-6.7
	Pacific Cod	2	1.8	1.8-1.9	0.014	0.013-0.016	0.12	0.07-0.16	0.32	0.29-0.35	0.38	0.33-0.42	0.04	0.04-0.05	0.26	0.25-0.28	0.07u	-	0.01u	-	5.2	5.0-5.3
	Pacific Tomcod	3	0.70	0.30-1.3	0.013	0.006-0.019	0.19	0.12-0.27	0.46	0.36-0.54	0.50	0.45-0.55	0.03	0.02-0.05	0.31	0.25-0.41	< 0.07	0.06-0.07u	0.009u	0.006u-0.01	5.3	5.0-5.5
	Flathead Sole	1	1.0	-	0.005u	-	0.47	-	0.25	-	0.35	-	0.04	-	0.50	-	0.30u	-	0.007u	-	4.3	-
	Pacific Hake	5	0.53	0.33-0.90	0.012	0.011-0.013	0.12	0.06-0.23	0.37	0.27-0.53	0.53	0.36-0.78	0.07	0.02-0.13	0.25	0.15-0.30	0.07u	-	0.01u	-	4.8	4.3-5.3

Table B-2 cont. Average Metal Concentrations Identified in Fish Muscle Tissue Sampled in the Commencement Bay Area and a Reference Station at Discovery Bay, ug/g wet weight

Station	Species	(N)	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
			Mean Range	Mean Range	Mean Range	Mean Range	Mean Range	Mean Range	Mean Range	Mean Range	Mean Range	Mean Range
Discovery Bay	Flathead Sole	1	5.3 -	0.004u -	0.07 -	0.28 -	0.31 -	0.04 -	0.20 -	0.07u -	0.01u -	4.0 -
	Pacific Staghorn Sculpin	5	2.0 0.90-3.1	< 0.004 0.004u-0.006	0.11 0.09-0.14	0.45 0.33-0.52	0.37 0.27-0.45	0.03 0.02-0.04	0.26 0.13-0.36	0.07u -	0.01u -	6.6 5.0-7.3
	English Sole	5	3.2 2.1-4.0	< 0.006 0.004u-0.008	0.06 0.05-0.07	0.42 0.40-0.44	0.46 0.31-0.61	0.04 0.02-0.05	0.23 0.17-0.33	0.07u -	0.01u -	5.2 4.3-7.0
	Pacific Tomcod	1	3.4 -	0.006 -	0.08 -	0.40 -	0.42 -	0.04 -	0.13 -	0.07u -	0.01u -	5.0 -
	Walleye Pollock	5	1.7 0.9-4.1	< 0.005 0.004u-0.006	0.07 0.05-0.12	0.53 0.33-0.93	0.35 0.31-0.42	0.08 0.03-0.11	0.21 0.17-0.26	0.07u -	0.01u -	5.2 4.7-6.7
	Starry Flounder	1	0.7 -	0.013 -	0.48 -	0.35 -	0.61 -	0.05 -	0.18 -	0.17 -	0.007u -	4.7 -

Table B-3.
Metal Concentrations Found in Fish Muscle Tissue Sampled at the Hylebos Waterway, ug/g wet weight

Lab. No.	Species	Sb	As	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Tl	Zn
36051	English Sole	.2u	7.0	.005u	.008	.62	.31	.36	.03	1.2	.08u	.007u	.04u	5.6
36052	English Sole	.2u	3.3	.005u	.006	.11	.26	.21	.03	1.2	.08u	.007u	.04u	4.8
36053	English Sole	.2u	7.3	.005u	.008	.15	.30	.27	.04	1.3	.38	.007u	.04u	5.0
36054	English Sole	.2u	4.1	.005u	.011	.17	.26	.21	.04	1.4	.08u	.007u	.04u	5.2
36055	English Sole	.2u	3.0	.005u	.006	.11	.25	.18	.02	1.2	.08u	.007u	.04u	5.0
44000	Whitespotted Greenling	.07u	.81	.006u	.006	.43	.35	.28	.23	.20	.08u	.01u	.04u	7.7
44001	Whitespotted Greenling	.07u	.44	.006u	.006	.65	.47	.37	.07	.17	.08u	.01u	.04u	9.0
44002	Whitespotted Greenling	.07u	.89	.006u	.019	.39	.44	.28	.22	.17	.08u	.01u	.04u	8.3
44003	Pacific Staghorn Sculpin	.07u	.51	.006u	.025	.34	.54	.70	.04	.10	.08u	.01u	.04u	7.0
44004	Pacific Staghorn Sculpin	.07u	.59	.006u	.020	.30	.44	.22	.02	.17	.08u	.01u	.04u	6.3
44005	Pacific Staghorn Sculpin	.07u	1.1	.006u	.017	.33	.65	.31	.01	.23	.08u	.01u	.04u	7.7

Table B-3. cont.

Metal Concentrations Found in Fish Muscle Tissue Sampled at the City Waterway, ug/g wet weight.

Lab. No.	Species	Sb	As	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Tl	Zn
29005	Pacific Tomcod	.07u	.5	.005	.006	.18	.54	.55	.03	.41	.06	.006u	.03u	5.5
46051	Pacific Tomcod	.07u	.3	.005u	.013	.27	.47	.51	.05	.25	.07u	.01u	.04u	5.0
46052	Pacific Tomcod	.07u	1.3	.005u	.019	.12	.36	.45	.02	.28	.07u	.01u	.04u	5.3
38022	Starry Flounder	.07u	2.1	.005u	.005u	.27	.30	.35	.04	.56	.3u	.007u	.04u	5.3
46050	Pacific Cod	.07u	1.9	.005u	.016	.16	.35	.33	.05	.28	.07u	.01u	.04u	5.3
46058	Pacific Cod	.07u	1.8	.005u	.013	.07	.29	.42	.04	.25	.07u	.01u	.04u	5.0
38026	Flathead Sole	.07u	1.0	.005u	.005u	.47	.25	.35	.04	.50	:3u	.007u	.04u	4.3
36050	English Sole	.07u	6.2	.005u	.005u	.26	.26	.20	.03	1.2	.07u	.01u	.04u	5.3
38021	English Sole	.07u	3.2	.005u	.005u	.64	.50	.45	.09	.52	.07u	.01u	.04u	7.7
38023	English Sole	.07u	2.8	.005u	.005u	.22	.27	.29	.03	.48	.07u	.01u	.04u	5.0
38024	English Sole	.07u	8.6	.005u	.005u	.20	.28	.32	.06	.54	.07u	.01u	.04u	5.0
38025	English Sole	.07u	4.5	.005u	.005u	.24	.27	.35	.01	.50	.07u	.01u	.04u	4.3
46053	Walleye Pollock	.07u	.97	.005u	.016	.12	.64	.66	.08	.15	.07u	.01u	.04u	6.0
46054	Walleye Pollock	.07u	.43	.005u	.016	.12	.71	.48	.07	.35	.07u	.01u	.04u	6.7
46055	Walleye Pollock	.07u	.93	.005u	.016	.09	.39	.42	.09	.25	.07u	.01u	.04u	5.3
46056	Walleye Pollock	.07u	.60	.005u	.013	.07	.56	.68	.06	.35	.07u	.01u	.04u	6.3
46057	Walleye Pollock	.07u	.93	.005u	.016	.07	.44	.45	.08	.40	.07u	.01u	.04u	6.0
46059	Pacific Hake	.07u	.47	.005u	.011	.23	.39	.50	.03	.30	.07u	.01u	.04u	4.3
46060	Pacific Hake	.07u	.57	.005u	.011	.06	.39	.78	.02	.20	.07u	.01u	.04u	5.3
46061	Pacific Hake	.07u	.33	.005u	.013	.09	.53	.45	.06	.30	.07u	.01u	.04u	5.0
46062	Pacific Hake	.07u	.40	.005u	.011	.11	.29	.36	.13	.30	.07u	.01u	.04u	4.3
46063	Pacific Hake	.07u	.90	.005u	.013	.11	.27	.57	.10	.15	.07u	.01u	.04u	5:0

Table B-3. cont.
Metal Concentrations Found in Fish Muscle Tissue Sampled at the Point Defiance Dock, ug/g wet weight

Lab. No.	Species	Sb	As	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Tl	Zn
28000	Rock Sole	.07u	2.5	.003	.006	.28	.40	.45	.05	.36	.25	.006u	.05u	8.8
29000	Rock Sole	.07u	11.9	.003	.008	.24	.47	.45	.03	.60	.18	.006u	.05u	8.8
29001	Rock Sole	.07u	34.1	.003	.008	.20	.35	.55	.02	.50	.29	.006u	.03u	9.8
29002	English Sole	.07u	14.6	.003	.012	.20	.49	.72	.03	.43	.17	.006u	.03u	7.0
29003	English Sole	.07u	3.2	.003	.004	.22	.42	10.4	.03	.40	.17	.006u	.03u	7.3
38027	English Sole	.07u	7.9	.003	.004	.41	.27	.67	.02	.73	.06u	.007u	.04u	5.3
29004	C-O Sole	.07u	37.8	.003	.006	.18	.44	.65	.02	.50	.06	.006u	.03u	10.7
38028	Buffalo Sculpin	.07u	3.6	.005u	.005u	.19	.37	.40	.02	1.0	.06u	.007u	.04u	10.7
01000	Walleye Pollock	.07u	2.2	.004u	.004u	.14	.71	.53	.08	.25	.07u	.007u	.04u	4.7
01001	Walleye Pollock	.06u	1.4	.004u	.004u	.11	.85	.61	.02	.40	.07u	.007u	.04u	4.7
01002	Walleye Pollock	.06u	1.9	.004u	.004u	.08	.85	.63	.02	.22	.07u	.007u	.04u	4.7
01003	Walleye Pollock	.06u	1.3	.004u	.004u	.11	.85	.63	.02	.19	.07u	.007u	.04u	5.3
01005	Walleye Pollock	.06u	.40	.004u	.004u	.12	.85	.63	.08	.22	.07u	.007u	.04u	6.0
01004	Pacific Staghorn Sculpin	.06u	.87	.004u	.004u	.12	1.2	.67	.03	.22	.07u	.007u	.04u	8.3
01006	Pacific Staghorn Sculpin	.06u	.67	.004u	.004u	.12	.66	.42	.03	.12	.07u	.007u	.04u	8.7
01007	Pacific Staghorn Sculpin	.06u	.60	.004u	.004u	.08	.80	.49	.07	.25	.07u	.007u	.04u	7.0

Table B-3.cont.
Metal Concentrations Found in Fish Muscle Tissue Sampled at the Old Town Dock, ug/g wet weight

Lab. No.	Species	Sb	As	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Tl	Zn
28001	Rockfish	.07u	.55	.003	.012	.28	.66	.58	.03	.48	.14	.006u	.04u	9.8
28002	Pacific Staghorn Sculpin	.07u	.31	.003	.012	.25	.72	.72	.03	.90	.12	.006u	.04u	10.0
29007	Buffalo Sculpin	.07u	.13	.005	.004	.15	.43	.58	.02	.43	.06u	.009	.03u	11.0
29006	Rock Sole	.07u	1.5	.005	.006	.14	.39	.81	.03	.50	.06u	.006u	.03u	6.8
44006	Rock Sole	.07u	7.8	.006u	.009	.28	.41	.33	.01	.27	.08u	.01u	.04u	6.0
29008	English Sole	.07u	3.2	.003	.006	.13	.40	.49	.02	.45	.12	.006u	.03u	6.0
29009	English Sole	.07u	2.1	.003	.008	.15	.35	.55	.04	.48	.15	.006u	.03u	5.5
29040	English Sole	.07u	3.4	.003	.006	.13	.40	.69	.02	.44	.09	.006u	.03u	6.3
49075	Walleye Pollock	.07u	1.1	.005u	.006	.09	.41	.31	.11	.20	.07u	.01u	.04u	5.7
49076	Walleye Pollock	.07u	3.4	.005u	.006	.12	.52	.31	.10	.17	.07u	.01u	.04u	5.0
49077	Walleye Pollock	.07u	1.7	.005u	.006	.07	.70	.31	.04	.27	.07u	.01u	.04u	4.7
49078	Walleye Pollock	.07u	1.8	.005u	.004	.07	.59	.42	.04	.37	.07u	.01u	.04u	5.3
49079	Walleye Pollock	.07u	1.4	.005u	.006	.07	.81	.36	.12	.33	.07u	.01u	.04u	6.0
49080	Pacific Cod	.07u	3.1	.005u	.004	.07	.52	.42	.12	.40	.07u	.01u	.04u	6.0
49081	Pacific Hake	.07u	.5	.005u	.004	.08	.33	.36	.07	.17	.07u	.01u	.04u	4.0
49082	Pacific Hake	.07u	.8	.005u	.004	.08	.33	.31	.09	.20	.07u	.01u	.04u	5.0
49083	Pacific Hake	.07u	.9	.005u	.004	.05	.41	.33	.13	.40	.07u	.01u	.04u	4.3
49084	Pacific Hake	.07u	.5	.005u	.004	.05	.41	.39	.11	.33	.07u	.01u	.04u	4.7
49085	Pacific Hake	.07u	.5	.005u	.016	.06	.67	.36	.11	.33	.07u	.01u	.04u	5.7

Table B-3. cont.
Metal Concentrations Found in Fish Muscle Tissue Sampled at Discovery Bay, ug/g wet weight

Lab. No.	Species	Sb	As	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Tl	Zn
40000	Starry Flounder	.07u	.70	.005u	.013	.48	.35	.61	.05	.18	.17	.007u	.04u	4.7
48005	Flathead Sole	.07u	5.3	.005u	.004u	.07	.28	.31	.04	.20	.07u	.01u	.04u	4.0
48014	Pacific Staghorn Sculpin	.07u	2.8	.005u	.004	.12	.52	.27	.02	.30	.07u	.01u	.04u	6.7
48015	Pacific Staghorn Sculpin	.07u	1.7	.005u	.006	.12	.44	.45	.04	.30	.07u	.01u	.04u	6.7
48016	Pacific Staghorn Sculpin	.07u	1.7	.005u	.004u	.09	.33	.42	.04	.23	.07u	.01u	.04u	5.0
48017	Pacific Staghorn Sculpin	.07u	3.1	.005u	.004u	.14	.48	.39	.04	.36	.07u	.01u	.04u	7.3
48018	Pacific Staghorn Sculpin	.07u	.9	.005u	.004	.09	.48	.31	.02	.13	.07u	.01u	.04u	7.3
48019	Pacific Tomcod	.07u	3.4	.005u	.006	.08	.40	.42	.04	.13	.07u	.01u	.04u	5.0
48000	English Sole	.07u	2.3	.005u	.006	.07	.40	.49	.04	.20	.07u	.01u	.04u	5.3
48001	English Sole	.07u	2.1	.005u	.006	.05	.44	.61	.05	.26	.07u	.01u	.04u	7.0
48002	English Sole	.07u	4.1	.005u	.004u	.05	.40	.46	.02	.33	.07u	.01u	.04u	4.3
48003	English Sole	.07u	3.6	.005u	.008	.07	.44	.31	.05	.17	.07u	.01u	.04u	4.7
48004	English Sole	.07u	4.0	.005u	.004u	.07	.40	.45	.04	.17	.07u	.01u	.04u	4.7
48007	Walleye Pollock	.07u	.9	.005u	.004u	.12	.93	.31	.03	.26	.07u	.01u	.04u	4.7
48008	Walleye Pollock	.07u	1.3	.005u	.006	.05	.33	.31	.09	.17	.07u	.01u	.04u	4.7
48010	Walleye Pollock	.07u	.9	.005u	.004	.05	.48	.39	.11	.17	.07u	.01u	.04u	4.7
48012	Walleye Pollock	.07u	4.1	.005u	.004u	.07	.59	.33	.08	.23	.07u	.01u	.04u	6.7
48013	Walleye Pollock	.07u	1.5	.005u	.006	.07	.33	.42	.08	.23	.07u	.01u	.04u	5.0

APPENDIX C.

Comparison of Organic Compounds Among Fish Species and Sampling Sites

NOTE: "m" indicates that a concentration falls between the detection level and the quantitation level for that compound

"<" denotes that quantifiable concentrations have been averaged together with "m" concentrations

For more information concerning detection limits see Appendix F page 115.

Table C-1. The Average Concentrations of Priority Pollutant Organics Identified in Fish Muscle Tissues Sampled at Four Commencement Bay Sites and a Reference Station at Discovery Bay
* = ug/kg wet weight ** = ug/g wet weight

	Point Defiance Dock					City Waterway					Old Town Dock					Hylebos Waterway					Discovery Bay				
Compound	Nd/Na	X̄	B	M	O	Nd/Na	X̄	B	M	O	Nd/Na	X̄	B	M	O	Nd/Na	X̄	B	M	O	Nd/Na	X̄	B	M	O
hexachlorobenzene *																4/9	<48.25	3	1	0					
isophorone *											1/12	920m	0	1	0										
naphthalene*						1/11	510	1	0	0															
n-nitrosodiphenylamine *											1/12	64	0	0	1										
bis(2-ethylhexyl) phthalate*	6/10	281	5	1	0	6/11	111.67	6	0	0	7/12	122.14	1	2	4	6/9	62.67	2	4	0	2/5	125	2	0	0
butylbenzyl phthalate *	2/10	385	1	1	0											2/9	54.5	0	2	0					
di-n-butyl phthalate *	2/10	595	1	1	0	5/11	598	5	0	0	5/12	342.4	1	0	4	6/9	266.7	3	3	0	2/5	120	2	0	0
diethyl phthalate *	6/10	87.5	5	0	1	8/11	< 33.38	7	0	1	10/12	67.9	4	3	3	7/9	35.29	5	2	0	2/5	< 54	2	0	0
dimethyl phthalate *																					1/5	8	1	0	0
phenol *	2/10	141.5	0	0	2	3/11	22.67	0	0	3															
1,1,1-trichloroethane **	2/16	0.04	0	1	1																				
1,2-trans-dichloroethylene **						2/22	0.01m	0	0	2															
ethyl benzene **						1/22	0.01m	0	0	1	1/19	0.01m	1	0	0										
methylene chloride **	8/16	0.48	0	3	5	2/22	0.18	0	0	2	3/19	0.53	0	0	3						1/18	0.1	0	0	1
tetrachloroethylene **																7/11	< 0.033	4	3	0					
toluene **	1/16	0.03	0	0	1																1/18	0.01m	1	0	0
trichloroethylene **																6/11	< 0.043	4	2	0					

(Nd/Na)= No. Fish with Detectible Values over No. Fish Analyzed (B)=Bottom Fishes (M)=Mixed Fishes (O)=Off-Bottom Fishes

Table C-2.

Concentrations of Priority Pollutants Found in Fish Muscle Tissue Sampled at:

Hylebos Waterway

Lab. No.	sp. Code	Base Neutral Extractables	hexachlorobenzene *	isophorone *	naphthalene*	n-nitrosodiphenylamine *	bis(2-ethylhexyl) phthalate	butylbenzyl phthalate *	di-n-butyl phthalate *	diethyl phthalate *	dimethyl phthalate *	Acid Extractables	phenol *	Volatiles	1,1,1- trichloroethane**	1,2- trans-dichloroethylene **	ethylbenzene**	methylene chloride**	tetrachloroethylene**	toluene**	trichloroethylene**
36051	(2)		50				60		450	40									0.05m		0.05m
36052	(2)		50				114			47									0.05m		0.05m
36053	(2)									34											
36054	(2)								600	50									0.05m		0.05m
36055	(2)		62						290	36									0.05m		0.05m
44000	(9)		31m				72	72	73	25											0.05m
44001	(9)		0	0	0	0	0	0	0	0	0		0								
44002	(9)						42	50											0.01m		0.01m
44003	(7)						26														
44004	(7)						62	37	134	15									0.01m		
44005	(7)		0	0	0	0	0	0	0	0	0		0						0.01m		

(0)= Base Neutral or Acid Extractible Fractions Not Analyzed For

(*)= Base Neutral or Acid Extractible Compound Expressed in ug/kg wet weight

(**)= Volatile Compound Expressed in ug/g wet weight

(2)= English Sole, (7)= Pacific Staghorn Sculpin, (9)= Whitespotted Greenling

Table C-2. cont.

Concentrations of Priority Pollutants Found in Fish Muscle Tissue Sampled at:

City Waterway

Lab. No.	sp. Code	Base Neutral Extractables	hexachlorobenzene *	isophorone *	naphthalene*	n-nitrosodiphenylamine *	bis(2-ethylhexyl) phthalate*	butylbenzyl phthalate *	di-n-butyl phthalate *	diethyl phthalate *	dimethyl phthalate *	Acid Extractables	phenol *	Volatiles	1,1,1- trichloroethane**	1,2- trans-dichloroethylene **	ethylbenzene**	methylene chloride**	tetrachloroethylene**	toluene**	trichloroethylene**
29005	(12)		0	0	0	0	0	0	0	0	0		0								
46051	(12)		0	0	0	0	0	0	0	0	0		0								
46052	(12)		0	0	0	0	0	0	0	0	0		0			0.01m	0.01m				
38022	(5)						160		580	35											
46050	(10)		0	0	0	0	0	0	0	0	0		0								
46058	(10)		0	0	0	0	0	0	0	0	0		0								
38026	(3)								430	30											
36050	(2)						170		580	45											
38021	(2)						180		700	50											
38023	(2)						60			30											
38024	(2)						80		700	35											
38025	(2)				510		20			25											
46053	(13)		0	0	0	0	0	0	0	0	0		0								
46054	(13)												35					0.3			
46055	(13)		0	0	0	0	0	0	0	0	0		0								
46056	(13)		0	0	0	0	0	0	0	0	0		0			0.01m		0.07			
46057	(13)																				
46059	(11)												21								
46060	(11)		0	0	0	0	0	0	0	0	0		0								
46061	(11)									17m			12								
46062	(11)		0	0	0	0	0	0	0	0	0		0								
46063	(11)		0	0	0	0	0	0	0	0	0		0								

(2)= English Sole , (3)= Flathead Sole , (5)= Starry Flounder , (10)= Pacific Cod , (11)= Paccific Hake , (12)= Pacific Tomcod , (13)= Walleye Pollock

Table C-2. cont.
Concentrations of Priority Pollutants Found in Fish Muscle Tissue Sampled at:

Old Town Dock

Lab. No.	sp. Code	Base Neutral Extractables	hexachlorobenzene *	isophorone *	naphthalene*	n-nitrosodiphenylamine *	bis(2-ethylhexyl) phthalate ·	butylbenzyl phthalate *	di-n-butyl phthalate *	diethyl phthalate *	dimethyl phthalate *	Acid Extractables	phenol *	Volatiles	1,1,1- trichloroethane**	1,2- trans-dichloroethylene **	ethylbenzene**	methylene chloride**	tetrachloroethylene**	toluene**	trichloroethylene**
28001	(8)									95											
28002	(7)			920m			190			130											
29007	(6)						140			70											
29006	(4)						140			95											
44006	(4)		0	0	0	0	0	0	0	0	0		0				0.01m				
29008	(2)									63											
29009	(2)								1300	120											
29040	(2)									80											
49075	(13)		0	0	0	0	0	0	0	0	0		0								
49076	(13)		0	0	0	0	0	0	0	0	0		0								
49077	(13)		0	0	0	0	0	0	0	0	0		0								
49078	(13)						110		100	6											
49079	(13)						190		110												
49080	(10)						59		62	7											
49081	(11)					64	26		140	13											
49082	(11)		0	0	0	0	0	0	0	0	0		0								
49083	(11)																	0.7			
49084	(11)		0	0	0	0	0	0	0	0	0		0					0.3			
49085	(11)		0	0	0	0	0	0	0	0	0		0					0.6			

(0)= Base Neutral or Acid Extractible Compounds Not Analyzed For

(*)= Base Neutral or Acid Extractible Compound Expressed in ug/kg wet weight

(**)= Volatile Compound Expressed in ug/g wet weight

(2)= English Sole,(4)= Rock Sole,(6)= Buffalo Sculpin,(7)= Pac. Stag. Sculpin,(8)= Rockfish sp.,(10)= Pac. Cod,(11)=Pac. Hake,(13)= Walleye Pollock

Table C-2. cont.

Concentrations of Priority Pollutants Found in Fish Muscle Tissue Sampled at:

Point Defiance Dock

Lab. No.	sp. Code	Base Neutral Extractables	hexachlorobenzene *	isophorone *	naphthalene*	n-nitrosodiphenylamine *	bis(2-ethylhexyl) phthalate *	butylbenzyl phthalate *	di-n-butyl phthalate *	diethyl phthalate *	dimethyl phthalate *	Acid Extractables	phenol *	Volatiles	1,1,1- trichloroethane**	1,2- trans-dichloroethylene **	ethylbenzene**	methylene chloride**	tetrachloroethylene**	toluene**	trichloroethylene**
28000	(4)																				
29000	(4)						230			120											
29001	(4)																				
29002	(2)						230			86											
29003	(2)						306			83											
38027	(2)						170	75	770	40											
29004	(1)						490			156											
38028	(6)						260	695	420												
01000	(13)		0	0	0	0	0	0	0	0	0		0					0.6			
01001	(13)		0	0	0	0	0	0	0	0	0		0					0.4		0.03	
01002	(13)		0	0	0	0	0	0	0	0	0		0					0.4			
01003	(13)									40			63			0.03		0.4			
01005	(13)												220					0.6			
01004	(7)		0	0	0	0	0	0	0	0	0		0			0.05		0.4			
01006	(7)		0	0	0	0	0	0	0	0	0		0					0.7			
01007	(7)		0	0	0	0	0	0	0	0	0		0					0.3			

(0)= Base Neutral or Acid Extractible Fraction Not Analyzed For

(*)= Base Neutral or Acid Extractible Compound Expressed in ug/kg wet weight

(**)= Volatile Compound Expressed in ug/g wet weight

(1)= C-O Sole, (2)= English Sole, (4)= Rock Sole, (6)= Buffalo Sculpin, (7)= Pacific Staghorn Sculpin, (13)= Walleye Pollock

Table C-2. cont.

Concentrations of Priority Pollutants Found in Fish Muscle Tissue Sampled at: Discovery Bay

Lab. No.	sp. Code	Base Neutral Extractables	hexachlorobenzene *	isophorone *	naphthalene*	n-nitrosodiphenylamine *	bis(2-ethylhexyl) phthalate	butylbenzyl phthalate *	di-n-butyl phthalate *	diethyl phthalate *	dimethyl phthalate *	Acid Extractables	phenol *	Volatiles	1,1,1- trichloroethane**	1,2- trans-dichloroethylene **	ethylbenzene**	methylene chloride**	tetrachloroethylene**	toluene**	trichloroethylene**
40000	(5)		0	0	0	0	0	0	0	0	0		0								
48005	(3)		0	0	0	0	0	0	0	0	0		0							0.01m	
48014	(7)		0	0	0	0	0	0	0	0	0		0								
48015	(7)		0	0	0	0	0	0	0	0	0		0								
48016	(7)		0	0	0	0	0	0	0	0	0		0								
48017	(7)		0	0	0	0	0	0	0	0	0		0								
48018	(7)		0	0	0	0	0	0	0	0	0		0								
48019	(12)		0	0	0	0	0	0	0	0	0		0								
48000	(2)		0	0	0	0	0	0	0	0	0		0								
48001	(2)						170		140	70	8										
48002	(2)		0	0	0	0	0	0	0	0	0		0								
48003	(2)						80		100	38m											
48004	(2)		0	0	0	0	0	0	0	0	0		0								
48007	(13)																				
48008	(13)		0	0	0	0	0	0	0	0	0		0								
48010	(13)		0	0	0	0	0	0	0	0	0		0								
48012	(13)																				
48013	(13)																	0.1			

(0)= Base Neutral or Acid Extractible Fractions Not Analyzed For

(*)= Base Neutral or Acid Extractible Compound Expressed in ug/kg wet weight

(**)= Volatile Compound Expressed in ug/g wet weight

(2)= English Sole, (3)= Flathead Sole, (5)= Starry Flounder, (7)= Pacific Staghorn Sculpin, (12)= Pacific Tomcod, (13)= Walleye Pollock

Table C-2A.

Concentrations of Priority Pollutants in Dungeness Crab Muscle Tissue Sampled at the Hylebos and City Waterways and Discovery Bay

	Base Neutral Extractables-	hexachlorobenzene *,a	isophorone *	naphthalene*	n-nitrosodiphenylamine *	bis(2-ethylhexyl) phthalate *	butylbenzyl phthalate *	di-n-butyl phthalate *	diethyl phthalate *	dimethyl phthalate *	Acid Extractables	phenol *	Volatiles -	1,1,1- trichloroethane**	1,1- dichloroethylene **	ethylbenzene**	methylene chloride**	tetrachloroethylene**	toluene**	trichloroethylene**
Hylebos Waterway																				
36058		0	0	0	0	0	0	0	0	0		0						0.01m		0.01 m
36059		0	0	0	0	0	0	0	0	0		0			0.01m		0.14			0.01 m
City Waterway																				
36056		0	0	0	0	0	0	0	0	0		0								
36057		0	0	0	0	0	0	0	0	0		0								
Discovery Bay																				
48006		0	0	0	0	0	0	0	0	0		0								
48011		0	0	0	0	0	0	0	0	0		0								

(a)= Not Analyzed For by GCMS but was Detected on GC/EC in Fish and Crabs from the Hylebos Waterway as Shown in Tables A-2 and A-3

(O)= Base Neutral or Acid Extractible Fractions Not Analyzed For

(*)= Base Neutral or Acid Extractible Compound Expressed in ug/kg wet weight

(**)= Volatile Compound Expressed in ug/g wet weight

Table C-3.
Non-Priority Pollutant Organic
Compounds Tentatively Identified
in Fish Muscle Tissue Sampled at:

Hylebos Waterway

Lab. Number	Species	trimethylamine	propanamine	benzaldehyde	benzeneethanol	1,3-benzdioxol-one, hexahydro,-trans-	benzoic acid, methyl ester	benzene, (1-methylethyl)-	benzene,1,2-dimethyl-	benzene,1,3-dimethyl	benzene,1,2,3-trimethyl-	benzene, ethyl-	benzene,1-ethyl-2-methyl-	benzene,1-ethyl-4-methyl	benzene,1-ethyl-4-(1-methylethyl)-	benzene,1,2-diethyl-	benzene,1,3-diethyl-	benzene,1,4-diethyl-	benzene, ethenyl-	benzene,1-ethenyl-3-ethyl-	benzene,1-ethenyl-4-ethyl-	
36051	English Sole																					
36052	" "																					
36053	" "																					
36054	" "			▨																		
36055	" "																					
44000	Whitesp. Greenling																					
44001	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
44002	" "																					
44003	Pac. Stag. Sculpin																					
44004	" " "																					
44005	" " "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

▨ Compound Detected

☐ Compound Not Detected

0 Base Neutral or Acid Extractable Compound Not Determined

Table C-3 cont.
Hylebos
Waterway

Lab. Number	butenoic acid, 2-methyl, methyl ester	butanoic acid, 2-methyl, methyl ester	butanoic acid, ethyl ester	pentenoic acid, methyl ester	2-pentanoic acid, methyl ester	hexanoic acid, methyl ester	hexanedioic acid, dihexyl ester	2-piperidene-carboxylic acid,1-acetyl, ethyl est	furan,2-pentyl-	2(5H)-furanone,5-ethyl-	acetone	2-butanone	2-pentanone	2-pentanone,3-methyl-	2-pentanone,4-methyl-	3-pentanone,2,4-dimethyl-	3-hexanone	3-hexen-2-one	heptanone	2 heptanone	propanal,2-methyl-	butanal	butanal,2-methyl-	butanal,3-methyl-
36051										▨														
36052										▨														
36053																								
36054										▨														
36055																								
44000												▨												
44001			0				0	0	0	0		▨				0		0						
44002											▨	▨									▨	▨		
44003											▨				▨						▨			
44004											▨	▨										▨		
44005			0				0	0	0	0	▨					0		0			▨	▨		

Table C-3.
cont.
Hylebos
Waterway

Lab. Number	ethane,1,1,2-trichloro-1,2,2-trifluoro-	ethane,1,1,2,2-tetrachloro-	hexane,2,4,4-trimethyl-	ethanol,2-(2-ethoxyethoxy)-	cyclohexene,3-(bromoethyl)-	2-cyclohexen-1-ol	2-cyclohexen-1-one	1,4-hexadiene,3-ethyl-	2H-pyran-2-one	2H-pyran-2-carboxaldehyde,5,6-dihydro-	dimethyl, disulfide	ethanethiol	pyrazine,2,5-dimethyl-
36051													
36052		▨	▨										
36053													
36054													
36055										▨			
44000													
44001		0	0	0	0	0	0	0	0	0			0
44002													
44003											▨		
44004													
44005		0	0	0	0	0	0	0	0	0			0

Table C-3.
Non-Priority Pollutant Organic
Compounds Tentatively Identified
in Fish Muscle Tissue Sampled at:

City Waterway

Lab Number	Species	trimethylamine	propanamine	benzaldehyde	benzeneethanol	1,3-benzdioxol-one, hexahydro,-trans-	benzoic acid, methyl ester	benzene, (1-methylethyl)-	benzene,1,2-dimethyl-	benzene,1,3-dimethyl	benzene,1,2,3-trimethyl-	benzene, ethyl-	benzene,1-ethyl-2-methyl-	benzene,1-ethyl-4-methyl	benzene,1-ethyl-4-(1-methylethyl)-	benzene,1,2-diethyl-	benzene,1,3-diethyl-	benzene,1,4-diethyl-	benzene, ethenyl-	benzene,1-ethenyl-3-ethyl-	benzene,1-ethenyl-4-ethyl-
29005	Pacific Tomcod		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46051	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46052	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46050	Pacific Cod		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46058	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38022	Starry Flounder																				
38026	Flathead Sole																				
36050	English Sole																				
38021	" "																				
38023	" "																				
38024	" "																				
38025	" "		▨												▨	▨	▨	▨	▨	▨	▨
46053	Walleye Pollock		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46054	" "			▨			▨														
46055	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46056	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46057	" "			▨	▨																
46060	Pacific Hake		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46061	" "			▨	▨																
46062	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46063	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46059	" "			▨	▨																

TableC-3.cont.

City Waterway

Lab. Number	butenoic acid, 2-methyl, methyl ester	butanoic acid, 2-methyl, methyl ester	butanoic acid, ethyl ester	pentenoic acid, methyl ester	2-pentanoic acid, methyl ester	hexanoic acid, methyl ester	hexanedioic acid, dihexyl ester	2-piperidene-carboxylic acid,1-acetyl, ethyl est	furan,2-pentyl-	2(5H)-furanone,5-ethyl-	acetone	2-butanone	2-pentanone	2-pentanone,3-methyl-	2-pentanone,4-methyl-	3-pentanone,2,4-dimethyl-	3-hexanone	3-hexen-2-one	heptanone	2 heptanone	propanal,2-methyl-	butanal	butanal,2-methyl-	butanal,3-methyl-
29005			0				0	0	0	0						0		0						
46051			0				0	0	0	0			▨	▨	▨	0		0	▨					
46052			0				0	0	0	0				▨	▨	0		0	▨					
46050			0				0	0	0	0				▨	▨	0		0						
46058			0				0	0	0	0						0		0						
38022																								
38026																								
36050																								
38021									▨															
38023																								
38024																								
38025																▨								
46053			0				0	0	0	0			▨	▨	▨	0		0						
46054												▨	▨	▨	▨									
46055			0				0	0	0	0						0		0						
46056			0				0	0	0	0				▨	▨	0		0						
46057									▨			▨		▨	▨									
46060			0				0	0	0	0			▨	▨	▨	0		0						
46061														▨	▨									
46062			0				0	0	0	0					▨	0		0						
46063			0				0•	0	0	0			▨	▨	▨	0		0						
46059												▨		▨	▨									

Table C-3. cont. City Waterway Lab. Number	ethane,1,1,2-trichloro-1,2,2-trifluoro-	ethane,1,1,2,2-tetrachloro-	hexane,2,4,4-trimethyl-	ethanol,2-(2-ethoxyethoxy)-	cyclohexene,3-(bromoethyl)-	2-cyclohexen-1-ol	2-cyclohexen-1-one	1,4-hexadiene,3-ethyl-	2H-pyran-2-one	2H-pyran-2-carboxaldehyde,5,6-dihydro-	dimethyl, disulfide	ethanethiol	pyrazine,2,5-dimethyl-											
29005		0	0	0	0	0	0	0	0	0			0											
46051	▨	0	0	0	0	0	0	0	0	0	▨		0											
46052		0	0	0	0	0	0	0	0	0	▨		0											
46050		0	0	0	0	0	0	0	0	0			0											
46058		0	0	0	0	0	0	0	0	0			0											
38022																								
38026																								
36050																								
38021					▨																			
38023							▨																	
38024								▨																
38025																								
46053		0	0	0	0	0	0	0	0	0	▨		0											
46054						▨	▨				▨													
46055		0	0	0	0	0	0	0	0	0	▨		0											
46056		0	0	0	0	0	0	0	0	0	▨		0											
46057																								
46060		0	0	0	0	0	0	0	0	0	▨		0											
46061											▨													
46062		0	0	0	0	0	0	0	0	0	▨		0											
46063		0	0	0	0	0	0	0	0	0	▨		0											
46059											▨													

Table C-3. cont.
Non- Priority Pollutant Organic
Compounds Tentatively Identified
in Fish Muscle Tissue Sampled at:

Old Town Dock

Lab. Number	Species	trimethylamine	propanamine	benzaldehyde	benzeneethanol	1,3-benzodioxol-one, hexahydro,-trans-	benzoic acid, methyl ester	benzene, (1-methylethyl)-	benzene,1,2-dimethyl-	benzene,1,3-dimethyl	benzene,1,2,3-trimethyl-	benzene, ethyl-	benzene,1-ethyl-2-methyl-	benzene,1-ethyl-4-methyl	benzene,1-ethyl-4-(1-methylethyl)-	benzene,1,2-diethyl-	benzene,1,3-diethyl-	benzene,1,4-diethyl-	benzene, ethenyl-	benzene,1-ethenyl-3-ethyl-	benzene,1-ethenyl-4-ethyl-
28001	Rockfish sp.																				
28002	Pac. Stag. Sculpin																				
29007	Buffalo Sculpin																				
29006	Rock Sole			▨																	
44006	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29008	English Sole																				
29009	" "			▨																	
29040	" "																				
49075	Walleye Pollock		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49076	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49077	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49078	" "																				
49079	" "																				
49080	Pacific Cod													▨							
49081	Pacific Hake												▨								
49082	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49083	" "			▨																	
49084	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49085	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

▨ Compound Detected ☐ Compound Not Detected [0] Base Neutral or Acid Extractable Compound Not Determined

Table C-3.
cont.
Old Town Dock

Lab. Number	butenoic acid, 2-methyl, methyl ester	butanoic acid, 2-methyl, methyl ester	butanoic acid, ethyl ester	pentenoic acid, methyl ester	2-pentanoic acid, methyl ester	hexanoic acid, methyl ester	hexanedioic acid, dihexyl ester	2-piperidene-carboxylic acid,1-acetyl, ethyl est	furan,2-pentyl-	2(5H)-furanone,5-ethyl-	acetone	2-butanone	2-pentanone	2-pentanone,3-methyl-	2-pentanone,4-methyl-	3-pentanone,2,4-dimethyl-	3-hexanone	3-hexen-2-one	heptanone	2 heptanone	propanal,2-methyl-	butanal	butanal,2-methyl-	butanal,3-methyl-
28001																								
28002																								
29007																								
29006										▨														
44006			0				0	0	0	0						0		0						
29008																								
29009												▨												
29040																								
49075			0				0	0	0	0						0		0						
49076			0				0	0	0	0						0		0						
49077			0				0	0	0	0						0		0						
49078																								
49079																								
49080																		▨					▨	▨
49081																								
49082			0				0	0	0	0						0		0						
49083		▨		▨									▨											
49084			0				0	0	0	0						0		0						
49085			0		▨	▨	0	0	0	0						0		0		▨				

Table C-3.
cont.

Old Town
Dock

Lab. Number	ethane,1,1,2-trichloro-1,2,2-trifluoro-	ethane,1,1,2,2-tetrachloro-	hexane,2,4,4-trimethyl-	ethanol,2-(2-ethoxyethoxy)-	cyclohexene,3-(bromoethyl)-	2-cyclohexen-1-ol	2-cyclohexen-1-one	1,4-hexadiene,3-ethyl-	2H-pyran-2-one	2H-pyran-2-carboxaldehyde,5,6-dihydro-	dimethyl, disulfide	ethanethiol	pyrazine,2,5-dimethyl-											
28001																								
28002																								
29007								▨																
29006																								
44006		0	0	0	0	0	0	0	0	0			0											
29008																								
29009																								
29040																								
49075		0	0	0	0	0	0	0	0	0			0											
49076		0	0	0	0	0	0	0	0	0			0											
49077		0	0	0	0	0	0	0	0	0			0											
49078				▨			▨																	
49079																								
49080																								
49081																								
49082		0	0	0	0	0	0	0	0	0			0											
49083											▨	▨												
49084		0	0	0	0	0	0	0	0	0	▨		0											
49085		0	0	0	0	0	0	0	0	0		▨	0											

Table C-3. cont.
Non-Priority Pollutant Organic Compounds Tentatively Identified in Fish Muscle Tissue Sampled at:

Point Defiance Dock

Lab. Number	Species	trimethylamine	propanamine	benzaldehyde	benzeneethanol	1,3-benzdioxol-one, hexahydro,-trans-	benzoic acid, methyl ester	benzene, (1-methylethyl)-	benzene,1,2-dimethyl-	benzene,1,3-dimethyl	benzene,1,2,3-trimethyl-	benzene, ethyl-	benzene,1-ethyl-2-methyl-	benzene,1-ethyl-4-methyl	benzene,1-ethyl-4-(1-methylethyl)-	benzene,1,2-diethyl-	benzene,1,3-diethyl-	benzene,1,4-diethyl-	benzene, ethenyl-	benzene,1-ethenyl-3-ethyl-	benzene,1-ethenyl-4-ethyl-
28000	Rock Sole																				
29000	" "																				
29001	" "																				
29002	English Sole																				
29003	" "																				
38027	" "						▨														
29004	C-O Sole																				
38028	Buffalo Sculpin																				
01000	Walleye Pollock	▨	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01001	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01002	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01003	" "							▨			▨										
01005	" "								▨	▨	▨	▨									
01004	Pac. Stag. Sculpin		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01006	" " "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01007	" " "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

▨ Compound Detected

☐ Compound Not Detected

0 Base Neutral or Acid Extractable Compound Not Determined

Table C-3.
cont.

Point Defiance Dock Lab. Number	butenoic acid, 2-methyl, methyl ester	butanoic acid, 2-methyl, methyl ester	butanoic acid, ethyl ester	pentenoic acid, methyl ester	2-pentanoic acid, methyl ester	hexanoic acid, methyl ester	hexanedioic acid, dihexyl ester	2-piperidene-carboxylic acid,1-acetyl, ethyl est	furan,2-pentyl-	2(5H)-furanone,5-ethyl-	acetone	2-butanone	2-pentanone	2-pentanone,3-methyl-	2-pentanone,4-methyl-	3-pentanone,2,4-dimethyl-	3-hexanone	3-hexen-2-one	heptanone	2 heptanone	propanal,2-methyl-	butanal	butanal,2-methyl-	butanal,3-methyl-
28000																								
29000											▨													
29001																								
29002																								
29003																								
38027									▨							▨								
29004							▨																	
38028										▨														
01000	▨		0				0	0	0	0				▨	▨	0	▨	0		▨				
01001			0				0	0	0	0					▨	0		0		▨				
01002			0				0	0	0	0						0		0						
01003										▨			▨							▨				
01005			▨												▨						▨			
01004			0				0	0	0	0						0		0		▨				
01006			0				0	0	0	0					▨	0		0						
01007			0				0	0	0	0					▨	0		0						

Table C-3.
cont.

Point Defiance
Dock

Lab. Number	ethane,1,1,2-trichloro-1,2,2-trifluoro-	ethane,1,1,2,2-tetrachloro-	hexane,2,4,4-trimethyl-	ethanol,2-(2-ethoxyethoxy)-	cyclohexene,3-(bromoethyl)-	2-cyclohexen-1-ol	2-cyclohexen-1-one	1,4-hexadiene,3-ethyl-	2H-pyran-2-one	2H-pyran-2-carboxaldehyde,5,6-dihydro-	dimethyl, disulfide	ethanethiol	pyrazine,2,5-dimethyl-
28000													
29000													
29001													
29002													
29003													
38027													
29004													
38028													
01000		0	0	0	0	0	0	0	0	0		▨	0
01001		0	0	0	0	0	0	0	0	0			0
01002		0	0	0	0	0	0	0	0	0			0
01003							▨						
01005									▨				
01004		0	0	0	0	0	0	0	0	0			0
01006		0	0	0	0	0	0	0	0	0			0
01007		0	0	0	0	0	0	0	0	0			0

Table C-3. cont.
Non-Priority Pollutant Organic
Compounds Tentatively Identified
in Fish Muscle Tissue Sampled at:

Discovery Bay

Lab. Number	Species	trimethylamine	propanamine	benzaldehyde	benzeneethanol	1,3-benzdioxol-one, hexahydro,-trans-	benzoic acid, methyl ester	benzene, (1-methylethyl)-	benzene,1,2-dimethyl-	benzene,1,3-dimethyl	benzene,1,2,3-trimethyl-	benzene, ethyl-	benzene,1-ethyl-2-methyl-	benzene,1-ethyl-4-methyl	benzene,1-ethyl-4-(1-methylethyl)-	benzene,1,2-diethyl-	benzene,1,3-diethyl-	benzene,1,4-diethyl-	benzene, ethenyl-	benzene,1-ethenyl-3-ethyl-	benzene,1-ethenyl-4-ethyl-
40000	Starry Flounder		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48005	Flathead Sole		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48014	Pac. Stag. Sculpin		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48015	" " "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48016	" " "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48017	" " "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48019	Pacific Tomcod		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48000	English Sole		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48001	" "			▨																	
48002	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48003	" "			▨																	
48004	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48007	Walleye Pollock																				
48008	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48010	" "		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48012	" "			▨																	
48013	" "			▨																	

▨	Compound Detected
☐	Compound Not Detected
0	Base Neutral or Acid Extractable Compound Not Determined

Table C-3.
cont.

Discovery Bay

Lab. Number	butenoic acid, 2-methyl, methyl ester	butanoic acid, 2-methyl, methyl ester	butanoic acid, ethyl ester	pentenoic acid, methyl ester	2-pentanoic acid, methyl ester	hexanoic acid, methyl ester	hexanedioic acid, dihexyl ester	2-piperidene-carboxylic acid,1-acetyl, ethyl est	furan,2-pentyl-	2(5H)-furanone,5-ethyl-	acetone	2-butanone	2-pentanone	2-pentanone,3-methyl-	2-pentanone,4-methyl-	3-pentanone,2,4-dimethyl-	3-hexanone	3-hexen-2-one	heptanone	2 heptanone	propanal,2-methyl-	butanal	butanal,2-methyl-	butanal,3-methyl-
40000			0				0	0	0	0		▨				0		0			▨			
48005			0				0	0	0	0						0		0		▨				
48014			0				0	0	0	0						0		0						
48015			0				0	0	0	0						0		0						
48016			0				0	0	0	0						0		0						
48017			0				0	0	0	0						0		0						
48019			0				0	0	0	0		▨				0		0			▨			
48000			0				0	0	0	0						0		0						
48001																								
48002			0				0	0	0	0		▨				0		0			▨			
48003								▨	▨															
48004			0				0	0	0	0		▨				0		0						
48007																								
48008			0				0	0	0	0		▨				0		0			▨			
48010			0				0	0	0	0		▨				0		0			▨			
48012									▨															
48013									▨															

Table C-3.
cont.

Discovery Bay

Lab. Number	ethane,1,1,2-trichloro-1,2,2-trifluoro-	ethane,1,1,2,2-tetrachloro-	hexane,2,4,4-trimethyl-	ethanol,2-(2-ethoxyethoxy)-	cyclohexene,3-(bromoethyl)-	2-cyclohexen-1-ol	2-cyclohexen-1-one	1,4-hexadiene,3-ethyl-	2H-pyran-2-one	2H-pyran-2-carboxaldehyde,5,6-dihydro-	dimethyl, disulfide	ethanethiol	pyrazine,2,5-dimethyl-
40000		0	0	0	0	0	0	0	0	0			0
48005		0	0	0	0	0	0	0	0	0			0
48014		0	0	0	0	0	0	0	0	0			0
48015		0	0	0	0	0	0	0	0	0			0
48016		0	0	0	0	0	0	0	0	0			0
48017		0	0	0	0	0	0	0	0	0			0
48019		0	0	0	0	0	0	0	0	0			0
48000		0	0	0	0	0	0	0	0	0			0
48001													
48002		0	0	0	0	0	0	0	0	0			0
48003													
48004		0	0	0	0	0	0	0	0	0			0
48007													
48008		0	0	0	0	0	0	0	0	0			0
48010		0	0	0	0	0	0	0	0	0			0
48012							▨						▨
48013													

APPENDIX D.

Biological Data

Table D-1. Collection and Biological Data for Fish and Crab Specimens Taken in Commencement and Discovery Bays.

E.P.A. Lab. No.	Station	Date of Collection	Time of Collection	Method of Collection	Species	Sex	Fork Length (mm)	Total Weight (g)	Total Fillet Weight (g)	Liver Weight (g)	Estimated Age (yrs)	Remarks
28000	Point Defiance Dock	7/15/81	1135	Hook + Line	Rock Sole *Lepidopsetta bilineata*	F	372	549.90	128.84	5.56	9	Posterior margin of caudal fin eroded.
28001	Old Town Dock	7/16/81	1840	Hook + Line	Rockfish sp. *Sebastes sp.*	F	195	136.64	33.77	3.08	3	
28002	Old Town Dock	7/16/81	1945	Hook + Line	Pac. Stag. Sculpin *Leptocottus armatus*	F	224	167.38	34.75	6.64	4	
29000	Point Defiance Dock	7/20/81	1230	Trawl	Rock Sole	M	198	76.02	23.91	1.00	4	Lesion on caudal peduncle, bleeding with opaque area surrounding it (blind side) Blind side with bloodworms.
29001	Point Defiance Dock	7/20/81	1230	Trawl	Rock Sole	F	195	101.32	32.43	0.91	3	Blind side with embedded bloodworms.
29002	Point Defiance Dock	7/20/81	1230	Trawl	English Sole *Parophrys vetulus*	M	280	162.03	43.73	2.71	4	Eyed and blind sides with embedded bloodworms.
29003	Point Defiance Dock	7/20/81	1230	Trawl	English Sole	F	234	113.41	30.30	2.52	4	Blind side with embedded bloodworms.
29004	Point Defiance Dock	7/20/81	1230	Trawl	C-O Sole *Pleuronichthys coenosus*	M	187	82.11	28.74	1.23	2	
29005	City Waterway (Totem Marina)	7/24/81	1145	Hook + Line	Pacific Tomcod *Microgadus proximus*	F	179	46.21	12.88	0.54	2	
29006	Old Town Dock	7/24/81	1015	Trawl	Rock Sole	M	226	151.17	49.60	3.36	3	
29007	Old Town Dock	7/24/81	1015	Trawl	Buffalo Sculpin *Enophrys bison*	F	285	615.75	65.97	22.46	-	Part of left maxillary appeared torn away.

Table D-1. cont. Collection and Biological Data for Fish and Crab Specimens Taken in Commencement and Discovery Bays.

E.P.A. Lab. No.	Station	Date of Collection	Time of Collection	Method of Collection	Species	Sex	Fork Length (mm)	Total Weight (g)	Total Fillet Weight (g)	Liver Weight (g)	Estimated Age (yrs)	Remarks
28008	Old Town Dock	7/24/81	1015	Trawl	English Sole	M	267	153.45	48.21	3.20	3	Eyed and blind sides with embedded bloodworms.
29009	Old Town Dock	7/24/81	1015	Trawl	English Sole	F	233	118.48	30.41	1.82	3	Eyed and blind sides with embedded bloodworms
29040	Old Town Dock	7/24/81	1015	Trawl	English Sole	M	237	115.76	34.63	1.72	3	Eyed and blind sides with embedded bloodworms
36050	City Waterway (Totem Marina)	9/10/81	1300	Trawl	English Sole	F	350	366.36	104.13	8.45	10	Blind side with red-gold pigmented areas (1-3mm diam.) caudal fin-reddish. Liver red
36051	Hylebos Waterway	9/10/81	1430	Trawl	English Sole	F	303	263.90	88.06	5.80	4	Liver yellowish/brown(pale)
36052	Hylebos Waterway	9/10/81	1430	Trawl	English Sole	F	282	197.58	68.95	4.95	4	Blind side with small(<1mm) red flecks toward posterior (raw appearance) Liver yellowish with red/brown splotches.
36053	Hylebos Waterway	9/10/81	1430	Trawl	English Sole	F	274	167.01	43.68	3.55	4	Liver yellowish/beige. Stomach with white/yellow nodules on exterior 3-4mm
36054	Hylebos Waterway	9/10/81	1430	Trawl	English Sole	M	265	161.91	55.14	2.50	-	Tip of blind side pectoral fin missing.
36055	Hylebos Waterway	9/10/81	1430	Trawl	English Sole	M	258	160.49	50.59	3.42	3	Liver yellowish with pink splotches.
36056	City Waterway (Totem Marina)	9/10/81	1300	Trawl	Dungeness Crab Cancer magister	M	181	868.06	217.53	-	-	Appearance good. Frozen before processing.
36057	City Waterway (Totem Marina)	9/10/81	1300	Trawl	Dungeness Crab	F	159	540.62	100.36	-	-	Appearance good. Frozen before processing.
36058	Hylebos Waterway	9/10/81	1430	Trawl	Dungeness Crab	F	118	223.05	49.99	-	-	Appearance good Frozen before processing. Recently molted (soft-shelled).

Table D-1.cont. Collection and Biological Data for Fish and Crab Specimens Taken in Commencement and Discovery Bays.

E.P.A. Lab. No.	Station	Date of Collection	Time of Collection	Method of Collection	Species	Sex	Fork Length (mm)	Total Weight (g)	Total Fillet Weight (g)	Liver Weight (g)	Estimated Age (yrs)	Remarks
36059	Hylebos Waterway	9/10/81	1430	Trawl	Dungeness Crab	F	140	376.45	59.01	-	-	Appearance good. Frozen before processing.
38020	City Waterway (Totem Marina)	9/23/81	1100	Trawl	Dungeness Crab	M	178	778.50	-	-	-	Appearance good. Small "scar" on left posterior portion of carapace.
38021	City Waterway (Totem Marina)	9/23/81	1100	Trawl	English Sole	M	263	148.70	36.43	2.60	6	Liver dark pink/purple.
38022	City Waterway (Totem Marina)	9/23/81	1130	Trawl	Starry Flounder *Platichthys stellatus*	M	271	184.46	53.8	2.96	5	Apparent hemorrahaging along dorsal, ventral and caudal fins Liver yellowish/rust with purple veins.
38023	City Waterway (Totem Marina)	9/23/81	1130	Trawl	English Sole	M	261	159.90	51.96	3.82	3	Liver cream/pink.
38024	City Waterway (Totem Marina)	9/23/81	1130	Trawl	English Sole	M	281	160.23	47.41	2.10	3	Bloodworms embedded on blind sides. Liver cream/pink.
38025	City Waterway (Totem Marina)	9/23/81	1130	Trawl	English Sole	M	289	178.27	48.00	2.98	5	Blind side with red (raw) tinge. Liver yellow/brown.
38026	City Waterway (Totem Marina)	9/23/81	1130	Trawl	Flathead Sole *Hippoglossoides elassodon*	F	240	125.80	46.09	2.83	3	Blind side with raw-looking pink/red splotches. Liver light cream brown.
38027	Point Defiance Dock	9/23/81	1400	Trawl	English Sole	F	276	160.90	47.43	3.08	6	Some erosion of dorsal and ventral fin membranes Liver brownish purple.
38028	Point Defiance Dock	9/23/81	1400	Trawl	Buffalo Sculpin	F	210	235.87	34.76	8.93	3	Liver yellow/orange
40000	Discovery Bay	10/6/81	1100	Trawl	Starry Flounder	F	471	1455.0	396.03	28.48	11	Several small lesions appearing red on blind side possibly associated with copepod parasites. Liver light yellow.
44000	Hylebos Waterway	11/5/81	1000-1300	Hook + Line	Whitespotted Greenling *Hexogrammos stelleri*	F	331	501.36	147.21	27.42	3	Stomach full of shrimp parts and one shrimp. Liver pink brown with surface white splotch-es

Table D-1 cont. Collection and Biological Data for Fish and Crab Specimens Taken in Commencement and Discovery Bays.

E.P.A. Lab. No.	Station	Date of Collection	Time of Collection	Method of Collection	Species	Sex	Fork Length (mm)	Total Weight (g)	Total Fillet Weight (g)	Liver Weight (g)	Estimated Age (yrs)	Remarks
44001	Hylebos Waterway	11/5/81	1000 1300	Hook + Line	Whitespotted Greenling	M	295	292.76	107.33	7.53	1	Liver is light gray with pink splotches.
44002	Hylebos Waterway	11/5/81	1000-1300	Hook + Line	Whitespotted Greenling	F	246	147.32	40.34	4.49	1	Ventral portion of caudal fin eroded. Liver purple/brown
44003	Hylebos Waterway	11/5/81	1000-1300	Hook + Line	Pacific Staghorn Sculpin	F	274	298.61	56.68	10.49	6	Liver light gray with pink splotches.
44004	Hylebos Waterway	11/5/81	1000-1300	Hook + Line	Pacific Staghorn Sculpin	F	235	173.60	37.37	5.18	3	Liver light gray with pink splotches.
44005	Hylebos Waterway	11/5/81	1000-1300	Hook + Line	Pacific Staghorn Sculpin	F	239	173.70	39.15	4.92	2	Liver light gray with pink splotches.
44006	Old Town Dock	11/5/81	1400	Hook + Line	Rock Sole	M	251	170.59	53.24	2.41	6	Bloodworms embedded on blind and eyed sides. Liver gray with pink tinge.
46050	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Pacific Cod *Gadus macrocephalus*	F	555	1912	495.91	76.20	3	Liver pale yellow with pink splotches.
46051	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Pacific Tomcod	M	265	179.65	53.80	7.28	5	Liver light gray with pink tinge.
46052	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Pacific Tomcod	M	266	153.37	47.10	2.82	5	Liver light gray with pink purple tinge.
46053	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Walleye Pollock *Theragra chalcogramma*	F	394	436.71	105.61	8.61	5	Liver gray with pink tinge.
46054	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Walleye Pollock	F	490	690.22	172.91	19.06	6	Liver light gray with pink tinge. Several small cyst-like structures on liver surface.

Table D-1. cont. Collection and Biological Data for Fish and Crab Specimens Taken in Commencement and Discovery Bays.

E.P.A. Lab. No.	Station	Date of Collection	Time of Collection	Method of Collection	Species	Sex	Fork Length (mm)	Total Weight (g)	Total Fillet Weight (g)	Liver Weight (g)	Estimated Age (yrs)	Remarks
46055	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Walleye Pollock	F	408	442.65	97.98	5.00	5	Caudal fin with flap of tissue above caudal peduncle. Upper lobe of caudal fin smaller. Open wound opposite flap. Liver thin, gray.
46056	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Walleye Pollock	F	389	381.29	92.68	11.24	4	Liver light gray.
46057	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Walleye Pollock	F	362	260.40	46.88	3.09	4	Upper lobe of caudal fin damaged Liver purple/brown with a few coiled(worm) cyst-like structures on surface.
46058	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Pacific Cod	M	442	913.00	227.70	12.45	2	Liver light brown with pink splotches.
46059	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Pacific Hake Merluccius productus	F	486	529.75	136.08	31.14	-	Liver light beige with purple veins in places.
46060	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Pacific Hake	F	437	536.89	132.80	40.60	-	Liver light beige.
46061	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Pacific Hake	F	437	411.72	121.51	17.32	-	Liver light beige with pink tinged splotches. Coiled roundworms on liver.
46062	City Waterway (totem Marina)	11/20/81	2030-2330	Hook + Line	Pacific Hake	F	420	454.91	75.52	11.03	-	Liver light beige with pink tinge.
46063	City Waterway (Totem Marina)	11/20/81	2030-2330	Hook + Line	Pacific Hake	F	458	454.84	104.37	28.79	-	Liver light beige.
48000	Discovery Bay	12/1/81	1000	Trawl	English Sole	M	281	209.51	67.61	4.64	5	Blind side with red flecks. Liver gray/brown with gray/white splotches.
48001	Discovery Bay	12/1/81	1000	Trawl	English Sole	M	314	240.42	56.89	4.21	-	Blind side with red flecks. Liver pink/beige.

Table D-1. cont. Collection and Biological Data for Fish and Crab Specimens Taken in Commencement and Discovery Bays.

E.P.A. Lab. No.	Station	Date of Collection	Time of Collection	Method of Collection	Species	Sex	Fork Length (mm)	Total Weight (g)	Total Fillet Weight (g)	Liver Weight (g)	Estimated Age (yrs)	Remarks
48002	Discovery Bay	12/1/81	1000	Trawl	English Sole	M	287	209.00	68.02	4.17	5	Blind side with red flecks. Liver pink/beige.
48003	Discovery Bay	12/1/81	1000	Trawl	English Sole	M	265	160.17	46.24	2.32	5	Blind side with red flecks. Liver pink/beige.
48004	Discovery Bay	12/1/81	1000	Trawl	English Sole	F	280	176.11	50.75	2.90	5	Blind side with red flecks. Liver. pink/beige.
48005	Discovery Bay	12/1/81	1000	Trawl	Flathead Sole	F	281	202.37	58.62	3.88	6	Blind side with few red flecks and some coloration. Liver: light pink/beige.
48006	Discovery Bay	12/1/81	1030-1230	Trawl	Dungeness Crab	M	186	807.23	118.70	9.59	-	4th leg (left) missing. Barnacles on carapace.
48007	Discovery Bay	12/1/81	1000-1230	Trawl	Walleye Pollock	F	280	204.30	52.54	10.82	2	Liver light peach.
48008	Discovery Bay	12/1/81	1000-1230	Trawl	Walleye Pollock	M	360	303.67	54.50	5.34	3	Liver pink/beige with scarlet edges.
48009	Discovery Bay	12/1/81	1030-1230	Trawl	Rock Crab *Cancer productus*	M	150	322.34	46.03	5.87	-	2nd leg(left)missing. Shell very brittle as if after molting.
48010	Discovery Bay	12/1/81	1000-1230	Trawl	Walleye Pollock	F	432	509.79	123.66	8.97	5	Liver pink with beige splotches.
48011	Discovery Bay	12/1/81	1030-1230	Trawl	Dungeness Crab	F	172	823.14	68.77	12.81	-	Carrying eggs.
48012	Discovery Bay	12/1/81	1000-1230	Trawl	Walleye Pollock	M	445	1028.98	282.45	80.46	7	Liver (large) pink/beige with coiled(worm-like) cysts on surface.

Table D-1. cont. Collection and Biological Data for Fish and Crab Specimens Taken in Commencement and Discovery Bays.

E.P.A. Lab. No.	Station	Date of Collection	Time of Collection	Method of Collection	Species	Sex	Fork Length (mm)	Total Weight (g)	Total Fillet Weight (g)	Liver Weight (g)	Estimated Age (yrs)	Remarks
48013	Discovery Bay	12/1/81	1000-1230	Trawl	Walleye Pollock	F	437	677.28	180.64	50.37	4	Liver light pink/beige with coiled (worm-like) cysts on surface.
48014	Discovery Bay	12/1/81	1000-1230	Trawl	Pacific Staghorn Sculpin	M	285	390.45	73.83	8.63	3	Liver pink/beige.
48015	Discovery Bay	12/1/81	1000-1230	Trawl	Pacific Staghorn Sculpin	F	260	233.45	38.11	4.33	3	Liver pink/beige with scarlet edges.
48016	Discovery Bay	12/1/81	1000-1230	Trawl	Pacific Staghorn Sculpin	M	301	446.16	66.48	8.38	2	Liver pink/beige with scarlet edges and tint.
48017	Discovery Bay	12/1/81	1000-1230	Trawl	Pacific Staghorn Sculpin	F	313	413.17	63.29	6.98	4	Liver brown/pink.
48018	Discovery Bay	12/1/81	1000-1230	Trawl	Pacific Staghorn Sculpin	F	224	150.82	29.60	3.51	2	Liver pink/brown.
48019	Discovery Bay	12/1/81	1000-1230	Trawl	Pacific Tomcod	-	200	72.71	19.18	2.14	3	Liver light gray/pink.
49075	Old Town Dock	12/10/81	2030-2330	Hook + Line	Walleye Pollock	M	364	392.43	104.72	18.35	3	Liver pink/beige with red splotches. A few worm-like cysts on surface.
49076	Old Town Dock	12/10/81	2030-2330	Hook + Line	Walleye Pollock	M	358	407.93	111.67	17.67	2	Liver light cream with red splotches. Some worm-like cysts on surface.
49077	Old Town Dock	12/10/81	2030-2330	Hook + Line	Walleye Pollock	M	273	208.37	55.17	13.27	1	Liver pink/light beige.
49078	Old Town Dock	12/10/81	2030-2330	Hook + Line	Walleye Pollock	M	272	171.58	48.30	5.81	2	Liver pink/beige.
49079	Old Town Dock	12/10/81	2030-2330	Hook + Line	Walleye Pollock	F	397	595.49	181.08	30.05	7	Liver pink/beige.

Table D-1. cont. Collection and Biological Data for Fish and Crab Specimens Taken in Commencement and Discovery Bays.

E.P.A. Lab. No.	Station	Date of Collection	Time of Collection	Method of Collection	Species	Sex	Fork Length (mm)	Total Weight (g)	Total Fillet Weight (g)	Liver Weight (g)	Estimated Age (yrs)	Remarks
49080	Old Town Dock	12/10/81	2030-2330	Hook + Line	Pacific Cod	M	442	880.31	271.68	13.91	6	Liver pink/beige.
49081	Old Town Dock	12/10/81	2030-2330	Hook + Line	Pacific Hake	F	453	676.14	176.51	74.03	-	Liver pink/beige
49082	Old Town Dock	12/10/81	2030-2330	Hook + Line	Pacific Hake	F	447	521.46	168.30	28.52	-	Liver pink/beige with a few coiled, worm-like cysts on surface.
49083	Old Town Dock	12/10/81	2030-2330	Hook + Line	Pacific Hake	M	404	398.40	109.12	20.23	-	Liver pink/beige.
49084	Old Town Dock	12/10/81	2030-2330	Hook + Line	Pacific Hake	F	444	409.97	109.05	15.63	-	Liver dark beige with pink/white splotches.
49085	Old Town Dock	12/10/81	2030-2330	Hook + Line	Pacific Hake	F	425	503.09	151.29	31.08	-	Liver light pink/beige with coiled worm-like cysts on surface (uncoiled 2.5cm).
01000	Point Defiance Dock	1/6/82	2000-2200	Hook + Line	Walleye Pollock	M	365	330.47	78.18	6.37	6	Copepod parasites on gills. Liver pink/beige.
01001	Point Defiance Dock	1/6/82	2000-2200	Hook + Line	Walleye Pollock	F	342	377.76	121.45	24.41	4	Liver light pink/beige.
01002	Point Defiance Dock	1/6/82	2000-2200	Hook + Line	Walleye Pollock	F	313	263.86	85.02	7.39	3	Liver light pink/beige.
01003	Point Defiance Dock	1/6/82	2000-2200	Hook + Line	Walleye Pollock	M	251	140.41	38.88	7.55	3	Liver light pink/beige
01004	Point Defiance Dock	1/6/82	2000-2200	Hook + Line	Pacific Staghorn Sculpin	F	257	204.74	44.52	5.42	3	Liver peach with red splotches.

Table D-1.cont. Collection and Biolgical Data for Fish and Crab Specimens Taken in Commencement and Discovery Bays.

E.P.A. Lab. No.	Station	Date of Collection	Time of Collection	Method of Collection	Species	Sex	Fork Length (mm)	Total Weight (g)	Total Fillet Weight (g)	Liver Weight (g)	Estimated Age (yrs)	Remarks
01005	Point Defiance Dock	1/7/82	1930-2130	Hook + Line	Walleye Pollock	F	402	378.19	82.58	4.09	5	Liver small, brown/beige with coiled worm-like cysts on surface.
01006	Point Defiance Dock	1/7/82	1930-2130	Hook + Line	Pacific Staghorn Sculpin	F	264	236.92	43.35	6.67	-	Liver peach with red splotches.
01007	Point Defiance Dock	1/7/82	1930-2130	Hook + Line	Pacific Staghorn Sculpin	F	277	279.14	57.85	10.23	2	Liver peach with red splotches.

APPENDIX E.

Analytical Methods

ANALYTICAL METHODS

Organic Analysis

Tissue Extraction Procedure

Approximately 30 g of fish muscle tissue was placed in a 100-mL fluted Virtis extraction flask with acid/neutral (A/N) and pesticide surrogate spikes and 100 mL of methylene chloride/methanol (2:1) solution. The tissue was ground for 1 minute with a Brinkman Polytron homogenizer. After filtering through a Whatman #1 filter using a Buchner funnel pre-rinsed with methylene chloride (CH_2Cl_2), the tissue was returned to the Virtis flask and the procedure was repeated twice. The residue was discarded after the final filtration.

The filtrate was filtered again by gravity through another Whatman #1 filter into a Kuderna-Danish (KD) concentrator, the solvent volume was reduced on a steam bath using a Snyder column to approximately 10 mL or until foaming occurred and persisted. The organic concentrate was transferred to a 1-L separatory funnel containing 500 mL of 2% Na_2SO_4 solution, whose pH was adjusted to 2. After the contents were shaken for 1 minute, the CH_2Cl_2 layer was allowed to separate and then drained into a second 500-mL separatory funnel. The extraction of the aqueous portion in the large separatory funnel was repeated twice, with two 50-mL portions of CH_2Cl_2, and the organic extracts combined in the 500-mL separatory funnel. The organic phase was washed twice with 25-mL portions of 2% Na_2SO_4 solution, pH adjusted to 2. Centrifugation was used, when necessary, to remove any emulsion. The aqueous portion was discarded.

The CH_2Cl_2 fraction was tranferred to a KD flask fitted with a Synder column, and the volume reduced to approximately 5 mL. The samples that were extracted prior to 3 December 1981 were evaporated to 4.0 mL with a nitrogen (N_2) evaporator and divided in half for A/N and pesticide analysis. Samples extracted after 3 December 1981 were reduced to 5.0 mL; 4.0-mL and 1.0-mL portions were taken for A/N and pesticide analysis, respectively.

Pesticide Extraction Procedure

Approximately 5 mL of hexane was added to the ampule containing the pesticide fraction. The ampule was then fitted with a micro-Snyder column and refluxed on a steam bath to remove the CH_2Cl_2. A Florisil column was prepared, rinsed with petroleum ether, and the hexane extract was transferred to the top of it. Two hundred milliliters of pentane was passed through the column and collected. This fraction was used for the analysis of polychlorinated butadienes (PCBD's) and PCB's. Next, 200 mL each of the 6%, 15%, and 50% diethyl ether/pentane mixtures were passed through the column, collected and combined. The ether/pentane solvent was replaced by iso-octane by use of a N_2 evaporator, and the volume was reduced to 2.0 mL before injection.

Acid/Neutral (A/N) Extraction Procedure

High molecular weight compounds were removed from the A/N fraction by gel permeation chromatography (GPC) in the following manner. Two teflon filters were placed in series (a 10 um filter was placed in front of the 0.2 um filter in a stainless steel filter holder). The filters and sample container were rinsed thoroughly with CH_2Cl_2 before samples were filtered. After filtering, the filtrate volume was reduced to 1 mL by evaporation with N_2. It was injected into the GPC, which was equipped with a precolumn of styragel (7 um size exclusion), and three microstyragel columns connected in series from the largest to the smallest size exclusion (10^4A, 500 A, and 100 A). A solution of 5% isopropanol in CH_2Cl_2 was used as the carrier solvent at 2 mL per minute. The first 13 minutes of eluate was saved for later analysis, if desired. The second fraction, containing the compounds of interest, was collected from 13 minutes to 24 minutes, reduced to 0.5 mL by N_2 evaporation, and analyzed by gas chromatography/mass spectrometry (GC/MS).

Gas Chromatography/Electron Capture Analysis

For the PCBD analysis, 5 mL of the pentane fraction was injected on a 3% OV-225 column at 40°C isothermally for second column confirmation, a 1% OV-1/2.4% OV-225 column at 40°C was used. Chromatography was completed in 15 minutes. For the regular pesticide/PCB analysis, the primary column contained 1.5% SP2250//1.95% SP2401, and the secondary column consisted of 4% SE-30//6% OV-210. Chromatography was completed in 30 minutes. The operating temperature for both columns was 200°C. Each column was glass and 6ft X 2 mm. The GC's were Tracor, Model 222, equipped with either Ni^{63} or H^3 electron capture detectors. Three levels of standards were injected daily before samples were analyzed. Per cent recoveries of the pesticide surrogate spike, o, p-'DDE, were calculated, but the pesticide results were not adjusted by these recoveries.

Gas Chromatography/Mass Spectrometry Analysis--Acid/Neutral Fraction

Selected tissue extracts from the A/N extraction procedure were analyzed by GC/MS using a 30 m DB-5 fused silica capillary column with splitless injection, and temperature programming from 50°C to 360°C at 8°C/minute. A Finnigan 3600 with INCOS data system was used.

Gas Chromatography/Mass Spectrometry Analysis---Volatile Organic Analysis (VOA)

Every sample was analyzed for VOA compounds. Approximately 1 g of finely sliced tissue was placed in a 40-mL screw cap vial and held at -12°C until ready for analysis. Just prior to purging, 10 mL of organic-free water containing the internal standards was added to the vial containing the thawed sample. The vial was connected to a Tekmar purge and trap instrument, heated in a 60°C water bath and sparged onto a trap containing 2/3 Tenax and 1/3 silica gel. The volatile compounds were desorbed at 180°C onto a 0.2% CW1500 stainless steel column (80-100 mesh, Carbopack C) held at 30°C. After desorption, the GC oven temperature was raised to 60°C and held for 2 minutes, and then programed at 8°C/minute to 180°C and held for 19 minutes. The GC/MS used was a Finnigan 3100D with a Riber SADR data system.

Table E-1.

EPA PRIORITY POLLUTANTS

METALS:

antimony
arsenic
beryllium
cadmium
chromium
copper
lead
mercury
nickel
selenium
thallium
zinc

MISCELLANEOUS:

cyanide
phenolics

PESTICIDES:

aldrin
dieldrin
chlordane
4,4' DDT
4,4' DDE
4,4' DDD
α endosulfan
B- endosulfan
endosulfan sulfate
endrin
endrin aldehyde
heptachlor
heptachlor epoxide
α BHC
B- BHC
δ BHC
γ BHC (lindane)
PCB 1242
PCB 1254
PCB 1221
PCB 1232
PCB 1248
PCB 1260
PCB 1016
toxaphene

BASE/NEUTRAL COMPOUNDS:

acenaphthene
benzidine
1,2,4-trichlorobenzene
hexachlorobenzene
hexachloroethane
bis(2-chloroethyl)ether
2-chloronaphthalene
1,2-dichlorobenzene
1,3-dichlorobenzene
1,4-dichlorobenzene
3,3'-dichlorobenzidine
2,4-dinitrotoluene
2,6-dinitrotoluene
1,2-diphenylhydrazine
fluoranthene
4-chlorophenyl phenyl ether
4-bromophenyl phenyl ether
bis(2-chloroisopropyl)ether
bis(2-chloroethoxy)methane
hexachlorobutadiene
hexachlorocyclopentadiene
isophorone
naphthalene
nitrobenzene
N-nitrosodiphenylamine
N-nitrosodipropylamine
bis(2-ethylhexyl)phthalate
benzyl butyl phthalate
di-n-butyl phthalate
di-n-octyl phthalate
diethyl phthalate
dimethyl phthalate
benzo(a)anthracene
benzo(a)pyrene
benzo(h)fluoranthene
benzo(k)fluoranthene
chrysene
acenaphthylene
anthracene
benzo(gni)perylene
fluorene
phenanthrene
dibenzo(a,h)anthracene
indeno(1,2,3-cd)pyrene
pyrene

VOLATILES:

acrolein
acrylonitrile
benzene
carbon tetrachloride
chlorobenzene
1,2-dichloroethane
1,1,1-trichloroethane
1,1-dichloroethane
1,1,2-trichloroethane
1,1,2,2-tetrachloroethane
chloroethane
2-chloroethylvinyl ether
chloroform
1,1-dichloroethane
trans-1,2-dichloroethane
1,2-dichloropropane
trans-1,3-dichloropropene
cis-1,3-dichloropropene
ethylbenzene
methylene chloride
chloromethane
bromomethane
bromoform
bromodichloromethane
fluorotrichloromethane
dichlorodifluoromethane
chlorodibromomethane
tetrachloroethene
toluene
trichloroethene
vinyl chloride

ACID COMPOUNDS:

2,4,6- trichlorophenol
p-chloro-m-cresol
2-chlorophenol
2,4-dichlorophenol
2,4-dimethylphenol
2-nitrophenol
4-nitrophenol
2,4-dinitrophenol
4,6-dinitro-2-methylphenol
pentachlorophenol
phenol

APPENDIX F.

Quality Assurance

QUALITY ASSURANCE

The purpose of quality assurance in a laboratory is to ensure the reliability and validity of data generated and help maintain control of the quality of data. Through the use of quality control (QC) samples and procedures, a more definite evaluation of the precision and accuracy of a determination can be obtained. The variations in data can then be attributed to real differences among samples, and trends in the data can be identified better.

Organic Parameters

Quality assurance (QA) for the tissue samples was measured through the use of surrogate spiking compounds in both tissue and quality control (QC) samples. QC samples comprised 28% of all samples analyzed. Table F-1 summarizes the QC work.

Table F-1 Quality Control Samples Analyzed

Fraction	Tissue Samples Analyzed	Blanks	Duplicates	Spikes
Base-Neutral/ Acid	49	5	6	3
VOA	92	27	6	6
Pesticide/ CB/PCBD	83	5	8	-

Acid/Neutral Fraction

The compounds used for surrogate spikes for the A/N fraction were decafluorobiphenyl, 2-fluorophenol, and pentafluorophenol. The average recovery ($\bar{x} \pm \delta$) for the surrogate spikes for 63 samples was 10% ± 24%, 37% ± 23%, and 3% ± 30%, respectively.

The average recovery for spiked acid and neutral compounds from three spiked samples, a total of 50 values, was 57% ± 44%. Di-n-butylphthalate and bis (2-ethyl-hexyl) phthalate were present in all samples and blanks at low levels. All data were reported uncorrected. In the six duplicate samples for the A/N fraction, only one sample had any target compounds that were detected. Six compounds were detected in sample 36050, but their concentrations were below the limit of quantitation. Only one of the six compounds was detected in the duplicate.

VOA Fraction

The surrogate compounds used in the VOA fraction were 2-bromo-1-chloropropane (BCP) and parafluorobromobenzene (PFBB). The surrogates were added to the water/fish mixture just prior to purging. The percent recovery for all samples, duplicates, and spikes averaged 103% ± 8.5% for BCP and 95.1% ± 10.5% for PFBB. THe VOA spiking compounds were added to the water/fish mixture just prior to purging. The average recovery for all spiking compounds in six samples, a total of 136 values, was 96.7% ± 29%.

Methlyene chloride, benzene, and toluene were always present in small amount in the VOA blanks. If the integrated areas of these compounds in the sample and blank were similar, then the compound was regarded as not being present. If the area in the samples was at least 5 times the area in the blank, the uncorrected concentration for the compound was reported.

In the six replicate samples of the VOA fraction, only two compounds were detected. Trichloroethylene was present below the limit of quantitation in both 44000 and its duplicate; methylene chloride was present in sample 49083 and its duplicate at the same concentration.

Pesticide/PCB Fraction

The surrogate spiking compound, o,p'-DDE, was used to monitor extraction efficiency. Unusually large dilutions and high PCB concentrations interferred with surrogate recovery computation and gave high results for six samples. However, the per cent recovery still averaged 98.7% ± 24.1% for 96 samples, duplicates, and 5 blanks. If these six results are deleted, the average per cent recovery is 94.5% ± 15.3%. The blanks were clean of target compounds.

In the pesticide fraction, only four different target compounds were detected in eight samples and their duplicates. The results are summarized in Table F-2.

Table F-2. Average Range of Duplicate Values for Compounds Detected in the Pesticide Fraction

Compound	Number of Times Detected	Average Range (ug/g, wet wt.)
4,4'-DDD	2	0.002
4,4'-DDT	6	0.002
4,4'-DDE	8	0.002
PCB 1254	6	0.027

DETECTION LIMITS

The limit of detection of a compound is defined as an analyte signal 3 standard deviations above the peak to peak noise level of the instrument in the region of the expected analyte peak. Any signal not exceeding this minimum response would be judged as not indicating the presence of the analyte. The limit of quantitation is defined as the analyte signal that is 10 standard deviations above the noise level of the instrument. Between these two limits is a region of detection in which a compound can be identified, but whose concentration is too low to allow an accurate estimate of its value (1).

The symbol "u" is used when the value preceding it is the quantitation limit for the particular substance. It means that the concentration, if any, falls below the detection limit. The symbol "m" indicates that the concentration of the substance falls between its detection limit and its quantitation limit. The symbol "<" is used in tables and bar graphs throughout the appendices, and is an artifact of averaging. When quantifiable values are averaged together with indeterminate "u" or "m" values the quotient is preceded by the "<" symbol.

The quantitation limits of all the target compounds and metals are listed in Table F-3 and F-4. The quantitation limits of the VOA compounds are generally lower than the A/N compounds because the purge and trap procedure eliminates many matrix problems.

Table F-3.

Detection Limits of Organic Compounds Analyzed in Commencement Bay Tissue *

		Organochlorine Compounds (ppb)			
Aldrin	1.	Endrin	1.	Hexachlorobenzene	1.
Chlordane	1.	Endrin Aldehyde	1.	Polychlorinated Butadienes	1.
Dieldrin	1.	Heptachlor	1.	PCB 1016	10.
4,4'-DDT	1.	Heptachlor Epoxide	1.	PCB 1221	10.
4,4'-DDE	1.	Alpha BHC	1.	PCB 1232	10.
4,4'-DDD	1.	Beta BHC	1.	PCB 1242	10.
Alpha Endosulfan	1.	Lindane	1.	PCB 1248	10.
Beta Endosulfan	1.	Delta BHC	1.	PCB 1254	10.
Endosulfan Sulfate	1.	Toxaphene	1.	PCB 1260	10.
		Neutral Compounds (ppb)			
Acenaphthene	10.	4-Chlorophenylphenylether	200.	Diethylphthalate	50.
1,2,4-Trichlorobenzene	20.	4-Bromophenylphenylether	40.	Dimethylphthalate	5.
Hexachlorobenzene	30.	bis (2-Chloroisopropyl)ether	5.	Benzo(a)anthracene	70.
Hexachloroethane	10.	bis (2-Chloroethoxy) methane	5.	Benzo(a)pyrene	40.
bis (2-Chloroethyl) ether	5.	Hexachlorobutadiene	30.	3,4-Benzofluoranthene	200.
2 Chloronaphthalene	5.	Hexachlorocylopentadiene	500.	Benzo(k)fluoranthene	60.
1,2-Dichlorobenzene	5.	Isophorone	500.	Chrysene	60.
1,3-Dichlorobenzene	5.	Naphthalene	2.	Acenaphthylene	2.
1,4-Dichlorobenzene	5.	Nitrobenzene	10.	Anthracene	5.
2,4-Dinitrotoluene	50.	N-Nitrosodimethylamine	500.	Benzo(ghi)perylene	300.
2,6-Dinitrotoluene	20.	N-Nitrosodiphenylamine	30.	Fluorene	5.
1,2-Diphenylhydrazine (as azo benzene)	5.	N-Nitrosodi-n-propylamine	500.	Phenanthrene	5.
Fluoranthene	30.	bis(2-Ethylhexyl)phthalate	10.	Dibenzo (a,h)anthracene	240.
		Butyl benzylphthalate	20.	Indeno (1,2,3-c,d)pyrene	300.
		Di-n-butylphthalate	3.	Pyrene	20.
		Di-n-octylphthalate	10.		
		Acid Compounds (ppb)			
2,4,6-Trichlorophenol	80.	2,4-Dimethylphenol	20.	4,6-Dinitro-o-cresol	250.
p-Chloro-m-cresol	40.	2-Nitrophenol	20.	Pentachlorophenol	40.
2-Chlorophenol	10.	4-Nitrophenol	2000.	Phenol	10.
2,4-Dichlorophenol	40.	2,4-Dinitrophenol	4100.		

*wet weight basis

Table F-3 cont.

Detection Limits of Organic Compounds Analyzed in
Commencement Bay Tissue *

		VOA Compounds (ppb)			
Acrolein	200.	Chloroethane	10.	Methyl Bromide	10.
Acrylonitrile	100.	Chloroform	10.	Bromoform	10.
Benzene	10.	1,1-Dichloroethylene	10.	Bromodichlomethane	10.
Carbon Tetrachloride	10.	1,2-trans-Dichloroethylene	10.	Trichlorofluoromethane	10.
Chlorobenzene	10.	1,2-Dichloropropane	10.	Dibromochloromethane	10.
1,2-dichloroethane	10.	cis-1,3-Dichloropropene	10.	Tetrachloroethylene	10.
1,1,1-Trichloroethane	10.	trans-1,3-Dichloropropene	10.	Toluene	10.
1,1-Dichloroethane	10.	Ethylbenzene	10.	Trichloroethylene	10.
1,1,2-Trichloroethane	10.	Methylene Chloride	10.	Vinyl Chloride	10.
1,1,2,2-Tetrachloroethane	10.	Methyl Chloride	10.	2-ChloroethylVinyl Ether	10.

*wet weight basis

Table F-4.

Detection Limits of Metals in Tissue

Element	Detection Limit (ppm-wet weight)
Antimony	.01
Arsenic	.01
Beryllium	.003
Cadmium	.002
Chromium	.005
Cobalt	.005
Copper	.005
Lead	.004
Mercury	.0001
Nickel	.005
Selenium	.01
Silver	.002
Thallium	.01
Zinc	.02